POWER

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Shorter Days or Fewer Years?

THE foreword under that title in the July 9 issue of *Power* has brought a number of communications and occasioned some discussion.

The proposition involves, of course, the worker's getting eight-fifths as much for an eight-hour day as he would get for a five-hour day.

If he can live as he wants to and ought to on what he can earn in five hours a day, he can save the extra three hours' pay to take care of him after his retirement.

He is putting in that extra time in the days of his youth, when it is not a hardship, so that he will not have to toil when the evil days come and he is less able to do so.

And for the support of his declining years he will, if he saves it, not only have the money that he earned while he was most capable of earning it, but he will also have the interest on that money up to the time that it is spent.

An engineer once told me how much a ten-minute shut-down cost the mill that he was running. The figure was astounding.

Interest, depreciation, insurance, taxes, unproductive salaries are going on whether a mill turns out much or little. The more hours it runs a day and the greater its output, the less its cost per unit of production.

And if the selling price is based on cost plus a fair profit, the workman, who is the largest purchaser and consumer, benefits again in the reduced cost of his living.

What is the use of building and supporting eight mills to perform a certain service when five would do it if they were run a full day?

The workman also has an overhead of his own. Suppose it takes him an hour to get from his breakfast table to his work and another hour to get from his work to his home. He would have to put in seven hours to earn five hours' pay, but only ten hours to earn eight hours' pay.

With the shorter day it would cost him just as much in fares, time, etc., to earn five-eighths as much. If he got eight hours' pay for five hours' work, there would have to be eight-fifths as many men employed at the higher wage and he would pay back his larger earnings in the consequent higher cost of living.

The foreword simply raised the question whether the surplus man power, due to the increasing ease with which the work of the world is coming to be done, cannot better be absorbed by working a smaller number of men full time while they are best able to work than to cut down the length of the working day and week so as to keep everybody working until he falls in his tracks.

F. R. Low

POWER *Stands for . . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**

Following the Leader In Building Engineering

THERE are fashions in everything—engineering equipment as well as women's shoes. If one looks over a number of large office buildings erected within any short period, a marked similarity will be noted in the mechanical details. Installation of a certain type of boiler marks one period; steam engines another; and central station current, with low-pressure boilers, a third.

Other influences besides that of conforming to popular practice govern many of these choices of equipment. For instance, a building with sufficient use for heating steam and hot water may find the best over-all economy through the use of uniflow engines and high-pressure boilers. In other cases, it may be that the rate for purchased current is so favorable that low cost lies in the selection of that service.

Where these factors decide the choice of building equipment it is evident that the installation will be sound from the broad engineering viewpoint. But where the selection has been made merely because the Nth National Bank Building in Podunk did the same thing, there is much left to be desired. Power service machinery for buildings should be chosen because it is the best available for the needs of that particular plant. Where the architect has no competent engineering force, it makes the employment of an outside consultant necessary. But the relatively small additional expense required for that purpose will quickly be saved in the operation of the building.

Tube Failures In Furnace Walls

TUBE failures that have occurred in the water-cooled side walls of some recent furnace installations, stoker-fired as well as pulverized-coal-fired, lead one to wonder whether there may be some fundamental cause for these failures or whether they are traceable largely to local conditions.

It would seem obvious that a tube whose clean inner surfaces are at all times wetted will not burn out. The difficulty must therefore be due to an insufficiency of water in the section that failed. The upper parts of these side-wall tubes contain mixtures of steam and water. The steam forms in bubbles along the inner surface, and unless these bubbles are swept away as fast as formed the surfaces of the tube become insulated by the bubbles. Hence rapid circulation is a prime essential to sweep these bubbles of steam from the heat-absorbing surfaces. The problem would therefore seem to be one of studying water circulation.

Water circulation, even in boilers, is a subject that is not always fully understood, and the newer constructions of side walls present new circulation problems even less well understood.

Many questions arise in connection with side-wall circulation. Should the circuit consist of down-comers from the main drum, through the side-wall tubes, and back by risers to the main drum? What sizes of pipe are needed in these down-comers and risers and how many of each should be used? Can water from the down-comers be distributed adequately to every side-wall tube? Will the risers relieve every tube so that none can become steam-bound? Recirculating tubes are widely used. Does the proper separation of water and steam take place in the top headers of the side walls so that recirculation of water can take place in these recirculating tubes only? How many recirculators should be provided in a given setting?

It is apparent that concentrated study of the problem from this standpoint should lead to remedies that will eliminate many of the present causes of failure.

Boiler Drums

THE power superintendent of a large industrial establishment writes: "I am appalled at the cost of maintaining a sulphate-alkalinity ratio in high-pressure boilers with riveted drums. With welded or forged drums I would be willing to disregard the sulphate-alkalinity ratio entirely."

One boiler manufacturer, who makes it a practice to inquire into feed-water conditions and, where necessary, cautions the prospective purchaser to maintain the ratio prescribed by the A.S.M.E. Code on the Care of Boilers, complained that this often places him at a disadvantage with certain customers, beside the competitor who is willing to take a chance without cautioning the purchaser.

A well-known firm of consulting engineers reporting upon the recent explosion of a boiler, apparently from caustic embrittlement, says: "The use of welded drums would have eliminated the trouble."

Similar observations from other sources leads one to wonder how general this feeling has become.

Research seems to have definitely confirmed the theory of caustic embrittlement and established its cause: the only debatable ground is the extent to which local stresses enter the picture. Likewise, the inhibition of such embrittlement seems to have been worked out to a reason-

able degree through employment of the sulphate or phosphate ratios. In other words, the ailment has been diagnosed and the medicine is found onerous. Many feel that welded drums would prove the solution to the problem.

Hammer welding, of course, has long been sanctioned by the A.S.M.E. Boiler Code, but the code committee has deemed it wise to proceed slowly in giving its approval to autogenous welding—gas or electric—in the absence of convincing research into methods of control and conclusive tests, as to the quality of the weld, that would have general application.

Unquestionably, facilities are at hand for making safe boiler drums by autogenous welding, and power plant practice is closer to the employment of welded drums that it was five years ago. It remains for a few such drums to be built as trial installations, under special authorization of the state inspectors concerned, and to be subjected to test and service conditions over a considerable period. If they satisfactorily meet all conditions, including longevity, a yardstick will have been established by which to construct others. If any unforeseen phenomena develop, the cause of safety will have been promoted through proceeding slowly.

Modernization at Low Expense

IMPROVEMENTS in power generation have come with extreme rapidity during the last fifteen years. In this time the heat required for the generation of one kilowatt-hour by the well-designed and well operated power plant has been cut in half. But unless rebuilt from the ground up, it is not possible for an existing plant to take full advantage of this gain. And so to rebuild a plant requires more capital investment than is usually forthcoming.

There is, however, an alternate course, as C. F. Hirshfeld points out elsewhere in this issue, that does not involve so much expense. Changes can be made that will preserve as much as fifty or sixty per cent of the original investment and still greatly improve the economy of generation. Often such a simple change as the introduction of improved combustion equipment, with perhaps the addition of water-cooling for the furnace walls, will make a great improvement with relatively low expenditure. Or such expedients as increased steam temperature, regenerative feed heating, or the addition of air preheaters will be found advantageous.

Thus it is not necessary for the industry that is saddled with an old and inefficient power plant to simply grin and bear it. Something can be done, at not too great cost, which will permit this plant to so rehabilitate itself as to realize, in large part, the economies of its most recently built competitor.

If the owners of inefficient or obsolete plants will but steel themselves to making the reduced investment necessary for such modernization, they will find that this money soon will be returned to them in direct savings in their power costs.

Rules, Regulations And the Law Not Enough

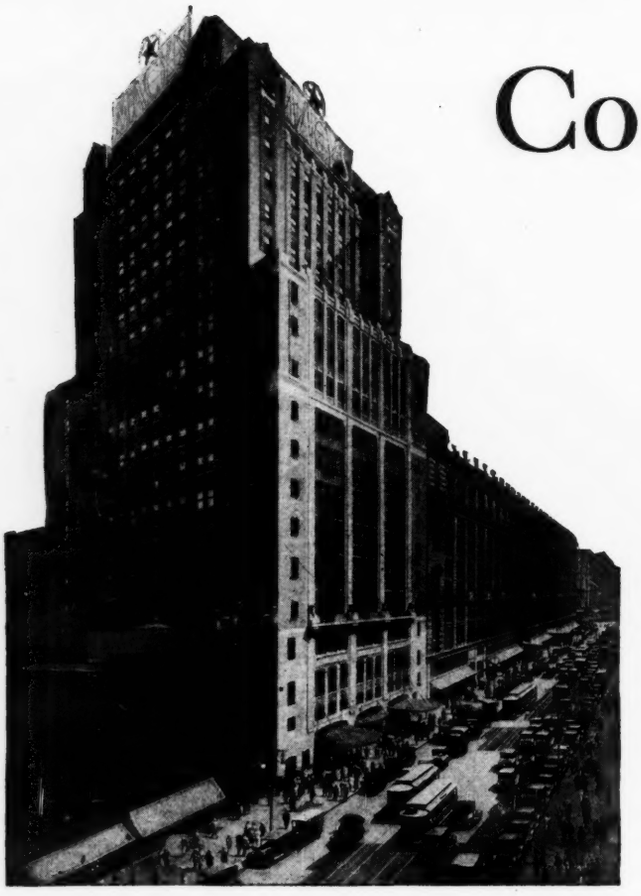
EVEN when the installation and operation of equipment is done according to the prescribed rules, regulations and laws on the statute books, it is not assurance that hazards to life and property do not exist. Many of the laws and regulations intended for safe practices in industry are either inadequate or have become antiquated and no longer meet present-day needs. In many states adequate safety laws have never been adopted, even when making manditory the code of a national engineering society is all that the legislative body has to do to put such regulations into force. This is traceable in some cases to political considerations and in others to the influence of local business that might be put to some expense thereby.

Many of those responsible for safe conditions in industry and other places take the position that when they comply with the law they have discharged their duty as citizens and as employers. If this had been the attitude of those who have done so much to make safe working conditions in the steel and other industries, thousands of people who are alive and normal today would have been crippled or dead. The wonderful safety records that are being made in some of these industries are due to compliance with the law when it is adequate and going beyond the statutes when this is required by safety. In such cases the object has been to make safe conditions and not just "get by" the law.

The knowledge that one has complied with the law should be little comfort in case of serious accidents that could be avoided by going beyond the law. After one or more persons have been injured or killed is not the time to think about removing the hazard. Notwithstanding this, there are many in responsible positions willing to take a chance, for commercial and other reasons, even when a hazard is known to exist. Some even go so far as to object to having equipment tested, to insure its safety, for no other reason than it may fail during the test. If the safeties on an elevator are going to fail the first time the car gets out of control, the way to find this out is by making a test on the machine without anyone in the car. The safeties may be allowed by law but that will not save the passengers from injury if the equipment fails when required to prevent the car from falling.

The insurance companies have to continually fight against hazardous conditions in equipment that is supposed to comply with the law. They have difficulty, even when the only question involved is making a test to determine that parts of the equipment are safe and will function properly when they are required. If municipal and state governments have been derelict in providing adequate laws for the safety of their citizens, it does not excuse the owners of buildings or the management of industries for being neglectful even if the law may allow this. Rules, regulations and the law should be complied with. When the law is not enough to make the equipment conform with safe practice, let safety first be the guide.

Conditioned Air *Cools* R. H. Macy's



R. H. Macy's: the largest department store in New York City

AS IN theaters, department store owners are much concerned with the comfort of their patrons. They know that whatever is done to make the store more attractive, to make purchasing easier and to insure courteous sales service will be reflected in increased business. With this in mind, R. H. Macy & Company, have recently placed in operation an air-conditioning system designed to maintain an inside temperature of ten degrees below the street temperature even on New York's hottest day. As a result shopping in this store is now more comfortable and more pleasant because of the invigorating effect on the sales force and the resulting better service.

The Macy store does the second largest business of any department store in the United States, and it is the first department store in New York to install air-conditioning equipment, though not the first in this country. It occupies the block between 34th and 35th Sts., extending 550 ft. from Broadway toward Seventh Avenue, and covers a street floor area of 88,800 square feet.

The street floor of any department store is always the most crowded as all the people entering the building must pass through it. Since crowding increases the discomfort of a hot day, because both temperature and humidity are increased, this of all spaces in the building should be ventilated and cooled. Also, this floor is surrounded with show windows, making natural ventilation difficult. Absence of windows in the basement makes the need of forced ventilation obvious, and heat from electric lights and from an engine room in the sub-basement makes cooling necessary if any degree of comfort is to be obtained. The upper floors, on the other hand, are not as crowded, and ample window ventilation makes air-conditioning not so important.

For these reasons it was decided to install air-conditioning equipment for the basement and street floor only. This, however, proved to be an undertaking of considerable magnitude, as the total volume of the air-conditioned space amounts to 2,300,000 cu.ft. Lay-out of the system was made difficult because space for air washers, fans and ducts was at a premium. Furthermore, construction had to be carried on without in any way interrupting the regular business of the store.

In order to maintain on these two floors a temperature below that outside, enough refrigeration had to be provided at least to remove all of the heat liberated in them. Five sources of heat had to be considered: heat given up by the average adult, heat from electric lights and motors, heat to be removed in order to effect dehumidification, heat removed to reduce fresh air to inside conditions and heat transferred through the building walls from the outside.

From actual counts it was determined that the basement and street floors together would have a maximum population of about 5,000. An average adult at a room temperature of 80 deg. gives off about 300 B.t.u. an hour when moderately active. In addition there is evaporated from the skin and exhaled from the lungs about 0.10 lb. of water vapor an hour per person. In order to keep down the per cent relative humidity, this moisture is removed by condensation, which requires the removal of about 1,060 B.t.u. per pound of water vapor. These two items require refrigeration amounting to slightly more than two million heat units an hour.

The electric energy used for lights and a few small motors amounts to 265 kw. an hour. As the heat equivalent of a kilowatt is 3,415 B.t.u., a total 904,975 heat units are emitted from this source.

The boiler room, which supplies steam for power generation and other heating services, extends through two stories and is therefore directly under the street floor of the middle building, while the engine room extends under the basement. In these rooms the temperature during a hot day runs over 100 deg. In calculating the heat transmitted through the floors it was necessary to take into consideration this unusually high temperature.

The heat transmitted through walls, floors and ceiling of the air-conditioned space, together with that required to cool the fresh air, raised the amount of heat to be removed to a total of 7,900,000 B.t.u.

To remove this amount of heat two 350-ton low-pressure centrifugal refrigerating machines were installed at the Broadway end of the sub-basement. Fig. 1 shows their location and a line diagram of the important piping.

These units are driven by 410-hp. 3,750-r.p.m. turbines supplied with exhaust steam from reciprocating engines in the power plant at a pressure of about a half pound per square inch. The turbines exhaust into surface condensers at a pressure which at present is averaging about 25-in. vacuum. Under these conditions the turbine steam rate is about 29.5 lb. per brake-horsepower. Circulating water is taken from the city water mains and used in the refrigerating units before passing to the steam condensers. It is estimated that during the hottest day about 1,600 g.p.m. will be required to condense the refrigerant and steam from the turbines.

Cooling water is pumped from a 7,000-gal. storage tank through the refrigerating machines, where its temperature is reduced to about 40 deg., depending upon outside conditions, and delivered to booster pumps, located at each of the air washers. Two pumps, one 2,200 g.p.m. driven by a 75-hp. motor and one 1,500 g.p.m. driven by a 40-hp. motor, were installed for the

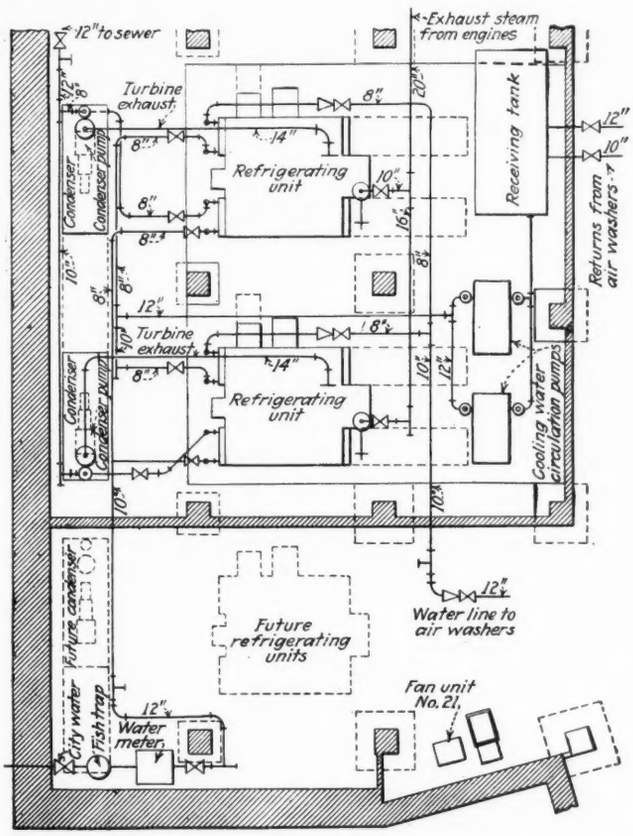


Fig. 1—Plan showing main piping and location of refrigerating units in Macy's sub-basement

purpose. The larger pump can circulate all the water required by the air washers during maximum load, thus leaving the smaller pump to act as a spare and for use during light loads. The circulating pumps are designed to work against a 100-ft. head, which is sufficient to overcome pipe line friction and deliver water at the elevation of the highest air washer.

There are seven air washers, two for the basement, two for the east building, two for the middle building and one for the west building. Their location is shown

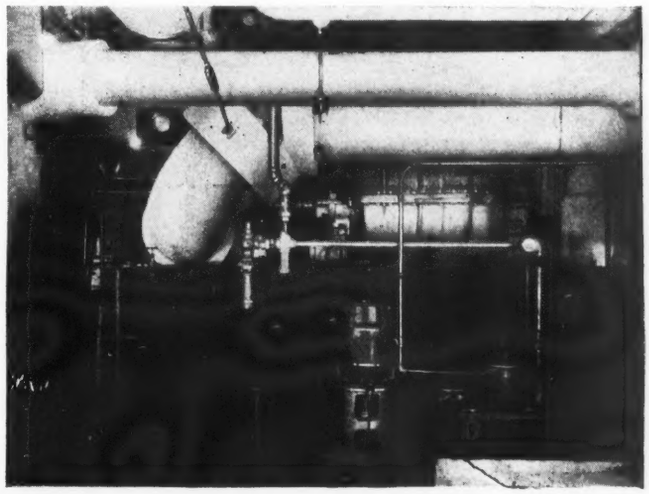


Fig. 2—One of the low-pressure turbine-driven 350-ton refrigerating units

in Figs. 2 and 3. At each of the air washers motor-driven booster pumps were installed, which deliver the cooling water to the air-washer nozzles at a pressure of 28 lb. This booster pump arrangement was installed in order to make the operation of the air washer more flexible. After passing through the air washers the cooling water returns by gravity to the storage tank in the refrigerating machine room.

Filtered and Return Air Mixed

Filtered fresh air and some returned air is drawn through the air washers into a suction plenum chamber. This air leaves the air washer with a temperature and dewpoint of about 50 deg. and mixes in the plenum chamber with the remainder of the return air, the final temperature of the mixture being about 60 deg. This cooled and dehumidified air is then picked up by the fan and blown out through the air distribution system. The air temperatures and dewpoint vary with outside conditions, the figures given being those expected during the hottest weather.

The volume of air required for the conditioning of the store spaces was not determined by any consideration of air changes or cubical contents. The air must be supplied at a temperature high enough to prevent obnoxious drafts and in sufficient quantity to absorb the sensible heat liberated in the ventilated space without having its temperature increased above that desired in the store. Thus, under the conditions of this installation, sufficient volume of air at 65 deg. must be supplied to remove about five million B.t.u. per hr. with a final room temperature of 85 deg., which is 10 deg. below an outside summer temperature of 95 deg. Thus

$$\frac{5{,}000{,}000 \times 56}{60 \times 25} = 233{,}000 \text{ c.f.m.}$$

(56 is the volume of air whose temperature is raised one degree by one B.t.u.).

Seven fans having a total capacity of 244,000 cu.ft. per min. were installed. The data in the table give the

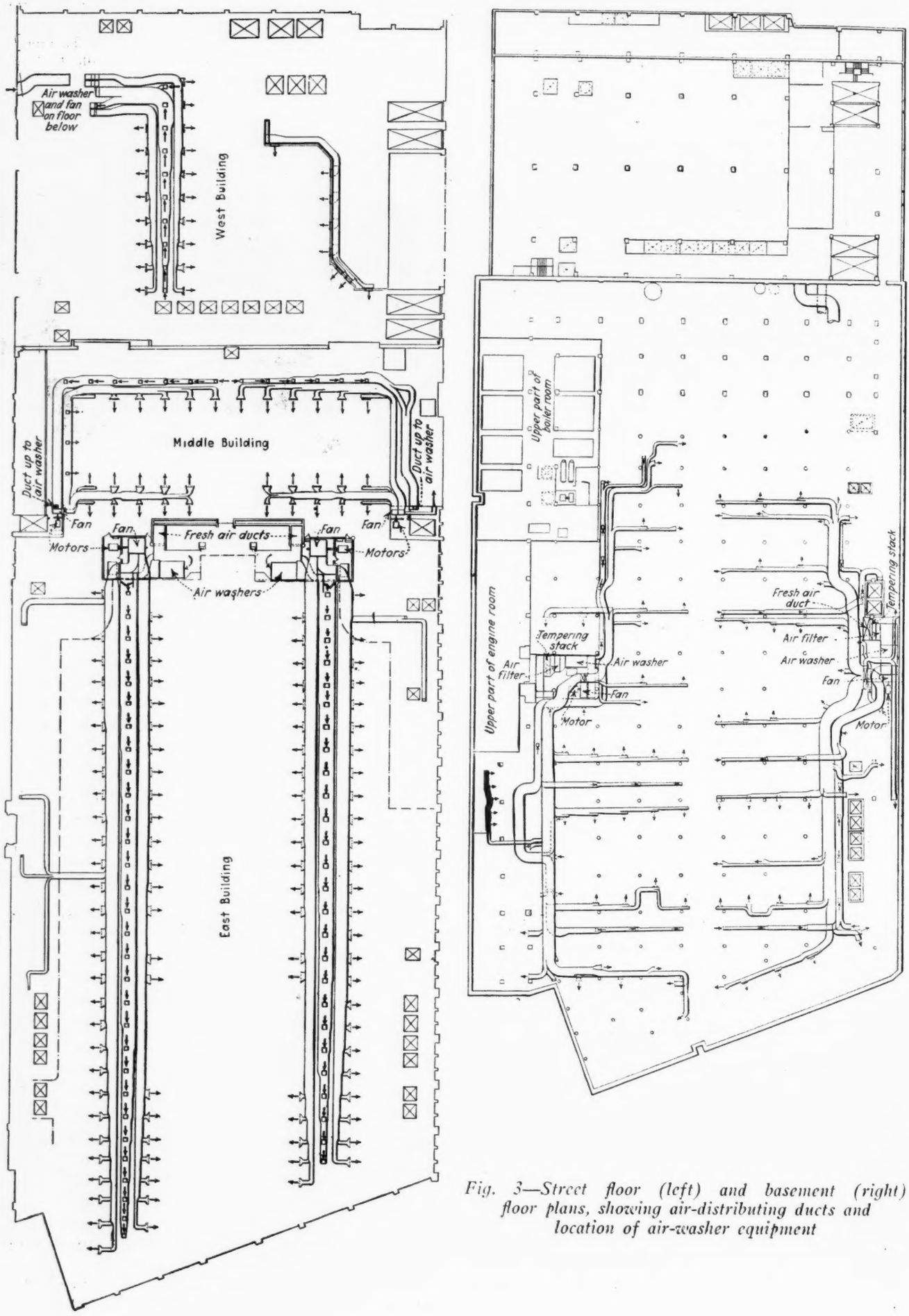


Fig. 3—Street floor (left) and basement (right) floor plans, showing air-distributing ducts and location of air-washer equipment

fan capacities, volume and area of space served and the resulting number of air changes:

	Area, Sq.Ft.	Volume, Cu.Ft.	Fan Capacity, C.F.M.	Air Changes per Hour
Basement	63,300	756,000	40,000 40,000	6.3
First floor, east bldg.	50,000	1,100,000	56,000 56,000	6.1
First floor, middle bldg.	19,700	192,000	12,000 12,000	7.5
First floor, west bldg.	19,100	292,000	28,600	5.9

Fig. 3 shows the arrangement of the ducts for distributing the cooled dehumidified air and for collecting the vitiated air. All of the duct inlet and outlet registers are at the ceiling. In the street floor of the east building two systems of ducts run the length of the floor. Each system comprises two supplies and one exhaust, which is located between the supply ducts. Cooled air is delivered horizontally and at right angles to the duct at a velocity of about 420 ft. a minute. The cooled air, being heavier, falls to the floor and spreads out over the entire area. The return air is drawn through openings in the bottom of the return air duct. As these openings are at the ceiling only the warmed-up air is removed, the horizontal velocity of the inlet air being sufficient to prevent short-circuiting.

It was not possible to carry out this system in the other sections of the building. As will be seen from the plans, the cooled air is carried to the center portions of the room by branch ducts, while most of the returns are taken through openings in ceiling ducts along the sides.

For winter operation, heating stacks have been installed at the inlet of each of the air washers. These heat the filtered fresh air passed through the air washers to the temperature required in the store. Exhaust fans located in various parts of the building remove air at a rate equal to the capacity of the supply fans.

Special attention was paid to the fan foundations, which were designed to dampen any noise caused by their operation. The foundations consist of six-inch thick timber and two inches of cork. The fans are fastened to the timbers, which, however, are not bolted to the floor. To further insure silent operation all connections between the fan casing and duct work were made with heavy canvas. The supply ducts were covered for a distance of 50 ft. from the fan outlets with asbestos air cells for sound-deadening purposes. Where the ducts were exposed and danger of sweating existed they were covered with 85 per cent magnesia.

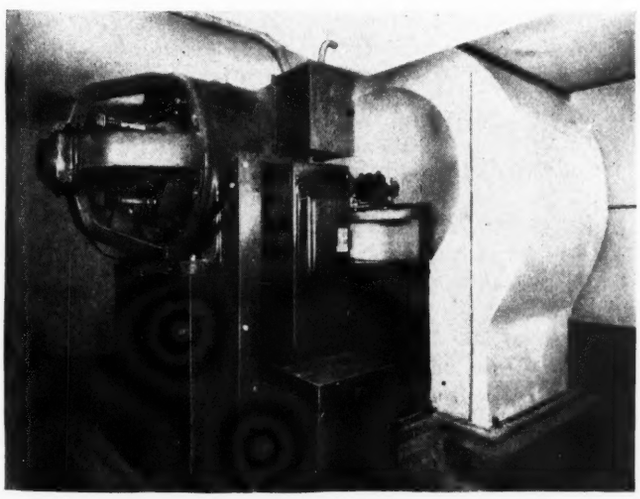


Fig. 4—One of the fans used to distribute cooled air to the basement floor

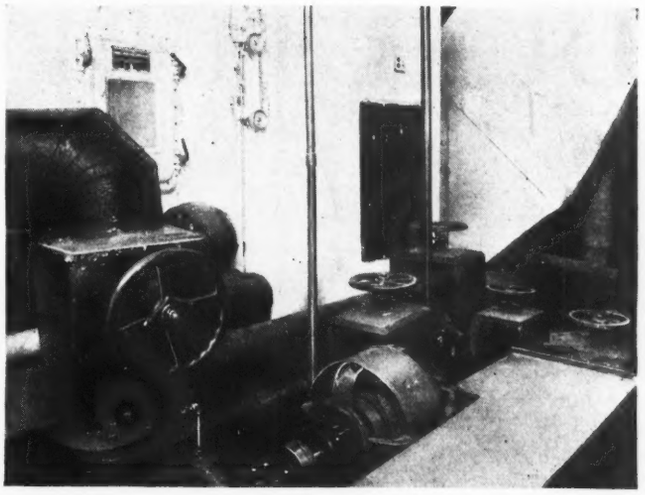


Fig. 5—Basement floor air washer and the pumps that deliver cold water to the washer spray nozzles

The air-conditioning system was designed and supervised by Werner Nygren, Inc., consulting engineers, New York City.

Color Should Not Be Made Criterion in Oil Specification

By H. L. Kauffman

THE importance of color is usually overestimated as a criterion of engine fuels, but since it is a property which is easily observed it continues to be an item in many specifications. The proper basis for the construction and enforcement of a color specification should be a full knowledge that color measurements on petroleum products are approximations only. By "approximations" is meant the common commercial methods of determining color by transmitted light, which consists in either measuring the depth of oil required to match a given color standard or observing the color standard required to match a given depth of oil.

While color is usually included in gasoline specifications, it does little more than to serve as an indication of the uniformity of quality and as a sign of freedom from contamination.

The chief significance of color as applied to lubricating oils lies in the fact that it is a generally accepted index of the uniformity of a given grade or brand, and serves as an aid in detecting contamination by dark-colored products. Here may be mentioned the fallacy which is so prevalent among consumers of lubricating oils, namely, that pale color indicates low viscosity. While it is generally true that the darker the oil the higher is likely to be its viscosity and carbon residue, there are so many exceptions that it is absurd to specify color as an indication of properties. In comparing oils of the same viscosity made from a given crude oil, it is generally true that the more complete the refining, the lighter the color. However, this does not necessarily mean any better performance in an internal-combustion engine, and the color test is of absolutely no value in judging the relative degree of refining in oils that have been made from different crudes.

DUAL-PURPOSE BOILER

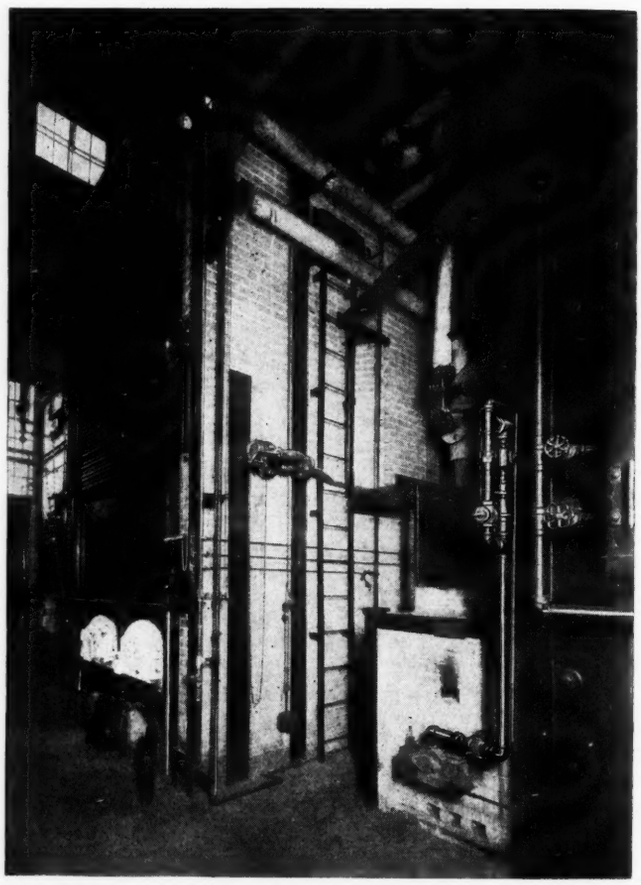
For Power and Testing

By George C. Fox
Engineer, C. H. Wheeler Manufacturing Company

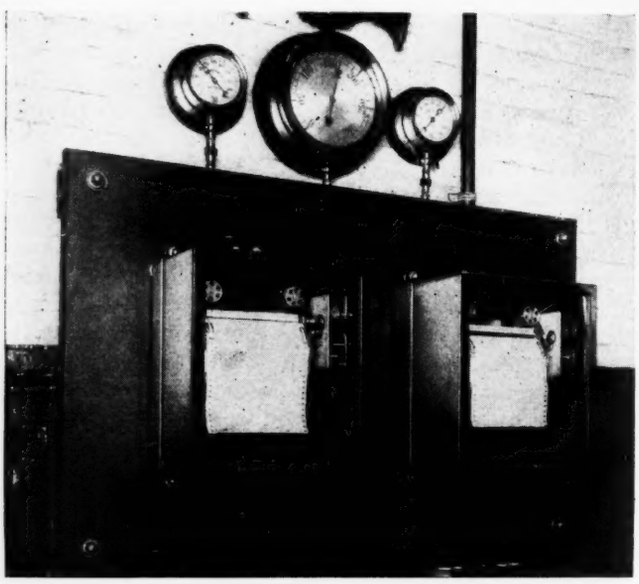
Test Boiler ***in works of C. H. Wheeler Manufacturing Company, Philadelphia, supplies 175-lb. saturated steam through a reducing valve for regular plant operation and testing steam at any desired pressure up to 425 lb. Temperature of the testing steam is automatically controlled by electrically regulated separately fired superheaters.***

AN INTERESTING boiler-room installation that supplies saturated steam at 175 lb. pressure for plant operation, while furnishing testing steam at closely regulated pressures and temperatures up to 425 lb. and 800 deg., has been in operation for some time in the plant of the C. H. Wheeler Manufacturing Company, Philadelphia. This double utilization of the test boiler is made possible by the use of separately fired superheaters whose gas burners are automatically controlled to maintain the desired temperature in the portion of the steam used for test purposes. The boiler is operated at the desired test pressure, the steam used for plant operation passing directly to a reducing valve without going through the superheaters.

Since it has always been the policy of the company to test thoroughly, before shipment, all condenser auxiliaries under conditions approximating as closely as possible the future actual working conditions of the equipment, the management early in 1927 foresaw the necessity of supplying its test department with steam at 400 lb. pressure or more and at any desired temperature up to 750 or 800 deg. F.



New boiler operates at 425 lb. pressure (Front of No. 1 superheater, with automatically controlled gas burners, is shown at the right.)



Steam conditions prevailing during the testing of each piece of apparatus are permanently recorded by two double-record, strip-chart instruments

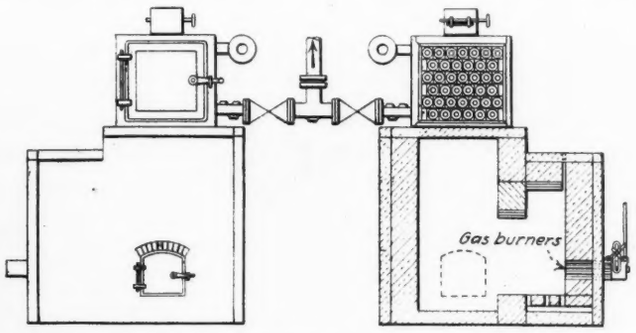
Instead of the usual small boiler for test purposes only it was decided to install a high-pressure boiler with sufficient capacity to operate the entire plant if necessary and at the same time supply the steam required for testing purposes.

In line with this determination an order was placed for a 425-lb. pressure Edgemoor water-tube boiler, which was erected in the power plant during the summer of 1927.

In order to secure flexibility and absolute control of steam temperatures, twin superheaters were installed in separate settings, either or both of which may be used, depending upon the amount of steam required on the test floor.

Since the other boilers in the power plant were fired with anthracite coal, it was decided to adapt the new boiler unit to the same fuel; but the superheaters, since they are used only intermittently, are conveniently gas fired from the city mains.

Any desired temperature up to 800 deg. may be automatically maintained by setting the temperature control index on an indicating thermo-electric pyrometer on the



Twin superheaters, separately fired, control temperature of steam for testing

test floor. This pyrometer electrically regulates the motor-operated gas-control valves near the superheaters.

In order to make the 400-lb. steam suitable for general plant purposes, for which the standard pressure is approximately 175 lb. gage, the pressure is reduced by a suitable regulating valve and the low-pressure part of the plant is amply protected by two large-capacity relief valves set to function at 200-lb. pressure.

One of the two boiler-feed pumps and also the closed feed-water heater for this high-pressure service were designed and built by the C. H. Wheeler Manufacturing Company. Feed water is supplied to the boiler at a temperature of from 205 to 215 degrees.

The entire installation is representative of thoroughly metered equipment. In the boiler room, near the boiler, are two circular-dial steam-flow indicating and integrating meters, one of which indicates the steam flow to the test department, the other showing the steam flow to the main plant. From these the total flow of steam for any predetermined period of time may be quickly and accurately ascertained.

A triple-draft gage shows at a glance the draft existing in each pass of the boiler, and the flue-gas temperature is duly recorded on a near-by circular chart recorder.

The indicating-steam-temperature automatic-control pyrometer is situated on the test floor proper, while near by is an instrument board which holds two double-record strip-chart recording instruments, one to record the steam flow and steam temperature in the line to the test floor. The other records the test steam pressure and the flow of low-pressure steam to the main plant. Directly above this board are three pressure gages, two of which show plant steam pressures and the third the plant air pressure.

This 425-lb. installation has been in operation for more than a year and has given but little trouble despite the necessity of making frequent piping changes on the test floor.

It has made possible the testing of Radojet air pumps, vacuum augmenters and other allied equipment at the steam pressure and temperature for which each machine was designed, thereby eliminating any question as to the proper performance of the equipment when finally installed by the purchaser.

Besides the high-pressure test floor mentioned above, two other test floors are maintained for the checking of circulating pumps, condensate pumps, jet condensers, etc.

Combination Leather and Cotton Belting

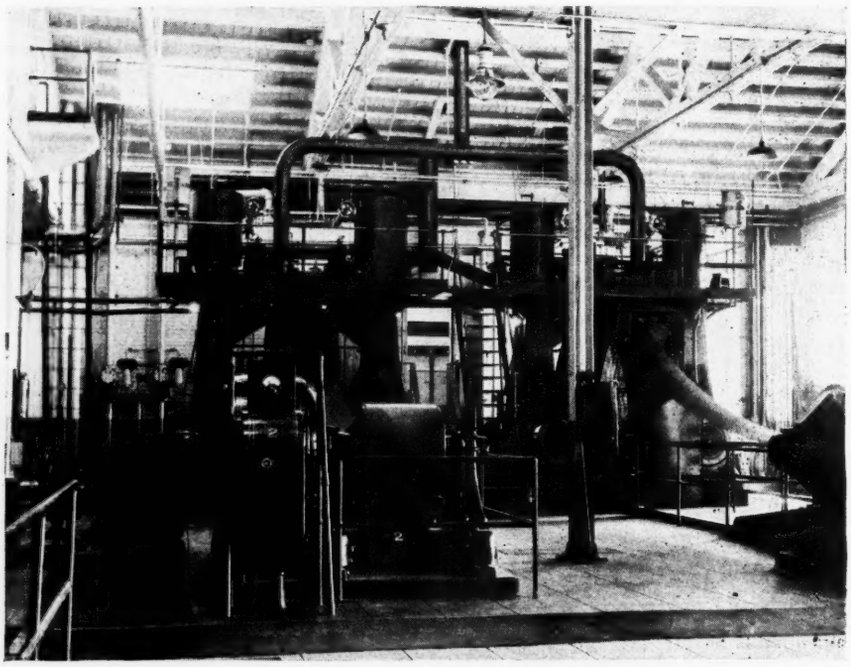
WRITING in *Power Transmission* under the title "Combination Belt Finds Favor With Plant Engineers," E. W. Zimmerman tells how old leather belts are taken apart and backed up with cotton to obtain a maximum service, greatly reducing cost to the user. The rules given are:

1. Purchase good quality double leather belt, either medium or heavy grade.
2. Use this belt as double leather just as long as it will stay together and pull. This usage may also include taking down and degreasing several times.
3. When the leather belt refuses to function any longer, pull the plies apart, thoroughly clean with gasoline and allow to dry. The bad spots are then cut out of the original belt and the good ends spliced as single ply.
4. Woven cotton belting of desired width and thickness is purchased and a roll of approximately 500 ft. stretched over rollers. This stretching is done a little at a time by a winch at each end. When all possible stretch is out of the canvas, it is sized with glue and allowed to dry.
5. A glue is made especially to cement the cotton to leather and to be pliable so as to travel over pulleys at a high speed without cracking.
6. The one ply of leather is then cemented to the canvas, the glue always being kept at the correct temperature by means of electrically regulated heat.
7. The finished belt is cut to proper width by bringing the leather down to the width of the canvas, the canvas edges not being cut.

When all the elements of this belt are properly made and carefully assembled, it produces satisfactory results. When ready to use, the leather is treated with a neatsfoot oil preparation and is mounted with the leather side to the pulley. The chief function of the leather is traction, while the cotton gives the strength.

Along with strength, the cotton also affords a resistance to stretching, which is not obtainable in leather belt unless the leather has previously been stretched beyond its elastic limit, which is poor policy. It is well known that every new leather belt needs several take-ups during the first month of its use in heavy service; but this is not necessary with the composite belt.

GRINDING WHEEL PRECAUTIONS—In mounting a grinding wheel, regardless of its size, it is highly important to use properly recessed flanges, to place washers of compressible material (blotting paper or rubber-gasket material) between the flanges and the sides of the wheel, and to avoid drawing up the flanges too tightly. The diameter of the flanges should not be less than one-half the diameter of the wheel, and they should be recessed at the center, so that the bearing surfaces in contact with the wheel will be annular and close to the circumference of the flanges.—*The Travelers Standard.*



Steam-driven compressors converted to motor drive

Ice Plant's Output Increased 75 Per Cent

By Inexpensive Alterations in Compressors

By James H. Hatch

IN REBUILDING its ice plant the Pasadena (Calif.) Ice Company was able to increase the capacity by 75 per cent through alterations to the existing compressors.

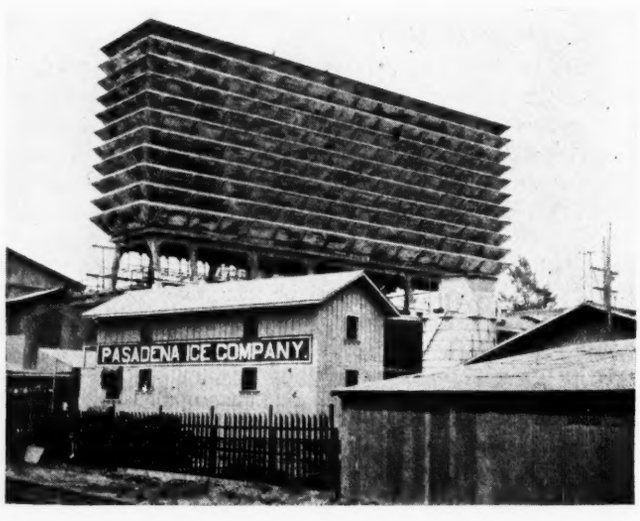
This plant has been making ice for 25 years, but was entirely rebuilt in 1926 and as now constituted contains not only the latest types of ice making machinery, but has several pieces of especially built equipment.

The capacity of this raw-water ice plant is 214 tons per 24 hr., in addition to the refrigeration of a large cold-storage plant operated in conjunction.

The main ice machines are two York vertical, single-acting units, each with two 16x24 in. cylinders operating at 89 r.p.m. These compressors were installed in 1906 and 1914, respectively, and were originally driven by Corliss cross-compound engines at 78 r.p.m. In rebuilding the plant the engines were taken out and replaced by two 250-hp., 440-volt, 3-phase, 50-cycle motors, operating at 485 r.p.m. The motors are belted to the compressors by 24-in. belts on 30-ft. centers. Together with the installation of improved machinery in other parts of the plant and improving the Voorhees multiple-effect compression, speeding up the compressors from 78 to 89 r.p.m. resulted in an increase in the capacity of each from 60 tons per day to 107 tons. Thus the capacity of the plant was increased 75 per cent by increasing the speed of the compressors 15 per cent in combination with the other improvements.

In addition to making 214 tons of ice, the compressors furnish refrigeration to maintain the proper temperature in three season ice-storage rooms, a daily ice-storage room holding 600 tons of ice, and to cool the brine for 228,000 cu.ft. of cold-storage space. The ice-making capacity equivalent to the cold-storage requirement is estimated at 18 tons, making a total duty on the compressors of 232 tons.

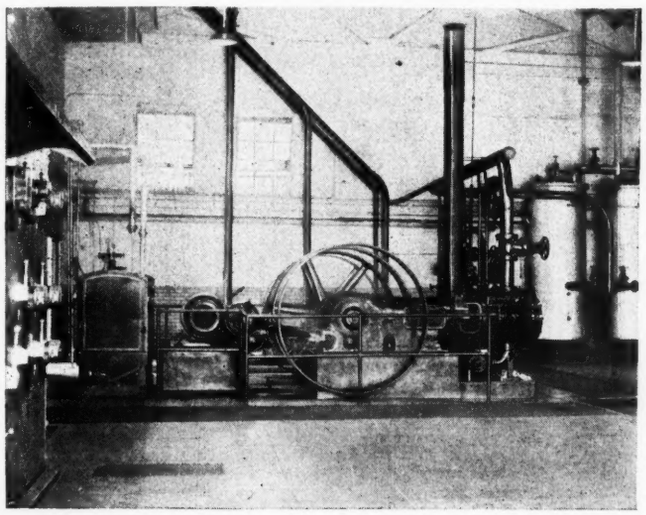
The anhydrous ammonia leaves the compressors at 140 lb. and a temperature of 208 deg. F. and goes to three York vertical shell-and-tube condensers located outside of the building. The condensers are 48 in. in diameter by 20 ft. high, and are mounted over a concrete water tank set eight feet above the ground. Any of



The cooling tower outside the plant

the three condensers can be shut down without disturbing the operation of the others. Water for circulation through the condenser tubes is supplied from an elevated wooden cascade-type cooling tower. This water is continually circulated by three 500-g.p.m. De Laval motor-driven centrifugal pumps, located in the power house. From the condensers the liquid ammonia goes into two eighteen-foot receivers, one 24 in. and the other 36 in. in diameter, having a capacity of about 184 cubic feet.

From the receivers the ammonia flows to the fore cooler, where it expands from 14 to 38 lb. pressure, lowering its temperature from 80 to 20 deg. F. That part of the ammonia changing into a gas is then drawn over to the main compressor at a pressure of 38 lb. gage, to be again compressed. The liquid ammonia



goes into a large trap, where the liquid level is automatically controlled by a float regulator, the valves of which operate directly on the main liquid feed to the fore cooler. From this trap the liquid ammonia goes to the pipe coils in the bottom of the brine tanks in the tank room, where it is drawn out of the coils and returned to the main compressors. The compressors are equipped with a Voorhees multiple-effect valve, which takes the gas at 38 lb. pressure as it comes from the fore cooler and at 27 lb. pressure as it comes from the brine tanks. Very little ammonia is lost in this system, only a small amount of make-up being added from time to time.

There is a false bottom in each brine tank, beneath which the ammonia pipes are carried in a pipe alley. The coil pressure is usually 27 lb. gage, giving a boiling temperature of 13 deg. F. so that the brine circulated around the coils is maintained at a temperature of about 15 degrees.

The brine in the two 40x96-ft. 1,360-can tanks, is kept in circulation by four motor-driven agitators, at one end of each tank. These agitators drive the brine from the surface of the tanks down into the pipe alleys beneath the false floor and along the alleys to the other end of the tank, bringing it constantly in contact with the cold ammonia pipes. The brine then rises above the false floor and flows through the spaces between the cans back to the agitator end of the tanks.

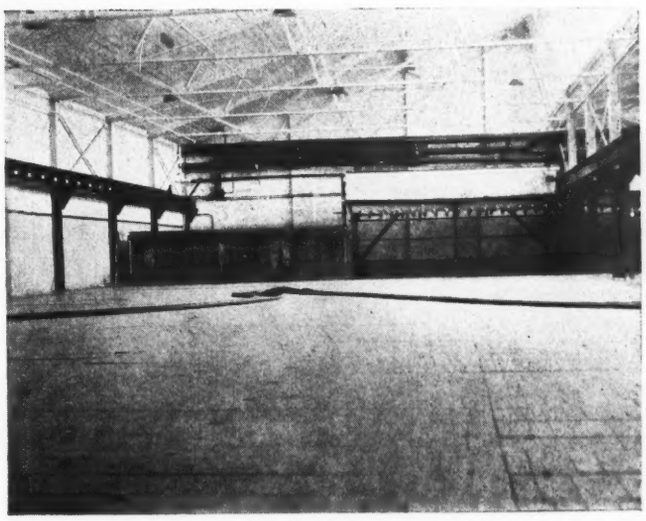
The cans are arranged in groups of seventeen and are handled by a four-ton Shepard electric crane, controlled by means of pull chords operated from the floor level.

When a group of seventeen cans is completed it is lifted out of the tank by the crane and carried to the end of the room and placed on the floor, where it is left to temper for 30 minutes to allow the cans to warm slightly before being immersed in the thawing water tank. The entire work in the freezing room is performed by one operator on each shift of eight hours.

The water from which the ice is made is pumped from a 160-ft. well by a Layne & Bowler 200 g.p.m. centrifugal deep-well pump into storage tanks above the roof, from which it flows by gravity to where it is needed. Water for drinking and general house service is used without treatment, as it comes from the pump. Water for the ice cans is run to a water purifier, where it is treated and filtered before going to the fore cooler. This fore cooler is a rectangular tank provided with

Right—Air compressors are motor driven with a gas engine as stand-by

Below—Cans are pulled in groups of seventeen



special agitation to bring the water constantly in contact with pipe coils in which cold ammonia is circulated. The temperature of the water is thus lowered to about 38 deg. F., and it then flows by gravity into the tank room, where it is used for filling the cans.

In the power house are located two 16x12-in. 250-r.p.m. Pennsylvania Pump & Compressor Company's air compressors. Normally these are not both operated at the same time, but are so arranged that either can be driven from a 50-hp. motor, which is belted to each of the compressors. There is also a four-cylinder gas engine located just behind the motor, which is arranged on a sliding frame so that if the motor should be out of commission either of the compressors can be run by the gas engine.

Air from the compressors at 30 lb. gage is taken to an air washer, where it is thoroughly cleaned of all dirt and oil and the preliminary heat of compression removed, after which it is put through a dehumidifier, where its

temperature is lowered to 20 deg. F. by passing it through one of two tanks inside of which are brine coils. The two tanks are operated alternately to permit of defrosting one while the other is in service. The cold, dry air is then carried over to the tank room and used for agitating the water during freezing. The air leaves the dehumidifier at 27 lb. gage and is passed through a reducing valve lowering it to 17 lb.; both of these pressures are used in freezing.

In addition to the two large ammonia compressors there is located in the power house a 7.5x7.5 in. York compressor driven by a 50-hp. G.E. motor. This machine is primarily for furnishing refrigeration for cold storage but is used in ice-making when needed. Also near this machine is a small high-pressure air compressor and receiver for furnishing air for operating air-driven machinery around the plant, such as drills and riveters.

A special 3-phase overhead power line is brought from the Pasadena municipal power plant, with a pole-top disconnecting switch installed on a pole at the ice plant. An underground cable runs from this pole to the main switchboard in the power house. Current is brought into the oil switches on the switchboard at 2,200 volts. This switchboard is of the "dead-front live-back" type, with all live contacts installed on the rear. The face of the board is well lighted with a diffused blanket of light. Besides the main board there are two sub-switchboards, one located in the tank room and the other in the cold-storage department.

Four voltages are used for power and lighting in the plant. All motors on the compressing and circulating machinery are 440-volt 3-phase, while all motors used in freezing and handling of the products are 220-volt 3-phase, and all lighting current is at 110- 220-volt single-phase. With the exception of the ammonia compressors, the large air compressors and the cranes, all motors are controlled by means of magnetic switches and push buttons.

Proper Inspections Make Electrical Equipment Safe

By Marin Phillips

TO MAKE electrical equipment safe it is necessary to have a well-planned system of inspection and repairs. It is essential that all operating equipment be given periodical inspections. The time which may elapse between these inspections will depend on the severity of the operating conditions. Some equipment may not need attention oftener than once in two or three months while some will require inspecting every two or three weeks.

Inspections when properly made will detect injured and oil-soaked insulation, loose or hot connections or similar defects before they became serious enough to cause accidents or shutdowns. Such inspections should be made by a competent electrician. As a few suggestions to the workman starting out to make an inspection: He might start at the motor and check the condition of the bearings. If they are worn sufficiently to allow the rotor to rub on the stator core, the winding will ground in a short time. The insulation of the winding should be inspected to see if it is old and worn, oil soaked, dirty or torn. The motor leads and wiring require looking over to see that joints are properly tapped and are not heating and that the insulation is in good condition.

Next, go to the starting and control equipment and check up for badly burned contacts, overheated or loose connections. Also note if workmen are using switch and other control cabinets for storing lunches, etc. Do all switches and controllers work freely or do they have to be operated out of the ordinary to open and close them? Are all the safety guards and covers in place? Is the equipment well protected against moisture, drips from pipes or sweating roofs? All these and other questions should be answered by the inspector.

So far the inspection may not have revealed anything that looks very serious; still some part of the equipment may fail at the next operation. The equipment should now be given an insulation test, using an insulator-resistance measuring device. If the test shows any part of the equipment to have a low insulation resistance, it should be dried out or repaired at once. Probably taking care of equipment will do much toward preventing electrical accidents and preventing unexpected shutdowns.

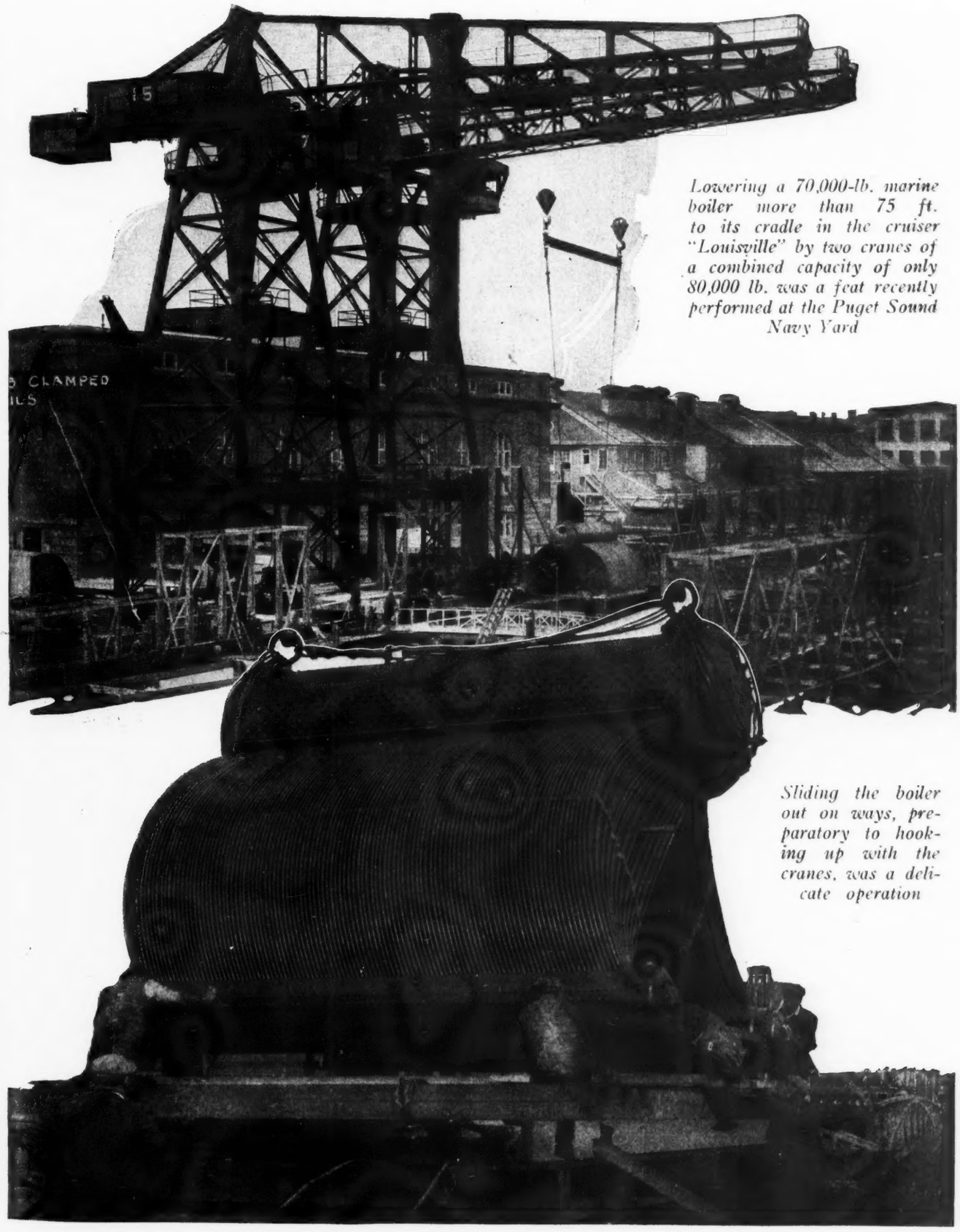
No matter how good the electrical equipment may be, it will not be safe or give the best results unless properly installed. When installing such equipment only well qualified workmen should be employed. Through lack of experience workmen may create unnecessary hazards, as well as interruptions to service, by careless connecting, soldering, and splicing.

As a protection to operators of electrical equipment, rubber mats or an insulated flooring of some kind should be placed in front of all switchboards motor control equipment, fuse-cutout panels and the like. These should be so placed as to afford protection against shock if any live parts are accidentally touched or some part of the equipment becomes charged through defective insulation. This does not mean that if such mats or insulation flooring are provided around high-voltage equipment that it will be safe to touch the live parts. On circuits of over 750 volts it is not safe to put any dependence upon this type of protection. There is always the possibility of a surface leakage or puncture, or the protection may be old and may have absorbed enough moisture to lower its insulating value. Where live high-voltage switches are to be opened or closed, a properly designed and maintained switch stick should be used. In places where the flooring is damp or wet a rubber mat is of very little use. The only way to assure a dry place for the operator is to make a wooden platform and mount it on insulators high enough to insure its surface remaining dry at all times. If the voltage is high enough to warrant it, a rubber mat may be placed on top of the platform as an extra precaution against shocks.

In plants and mines where trolley wires are used, the bare wire creates a more or less dangerous hazard. If it is possible such wires should be placed at least eight feet above the floor or standing level. In places where there is the possibility of workmen coming in contact with the trolley wire it should be protected with some form of a box-like guard that will cover the sides of the wire. That is, a box guard made with a slot or opening wide enough for the arm carrying the current-collecting shoe or trolley wheel to travel through.

The Donipihan Hydro-Electric Company has applied for a license to construct a dam and power house integral therewith on the Current River, in Ripley and Carter Counties, Mo., creating a reservoir of about 33,000 acres. It is planned to operate the plant under a head of approximately 100 feet and have an installed capacity of 48,000 hp.

Hazards of Marine Boiler Setting



Lowering a 70,000-lb. marine boiler more than 75 ft. to its cradle in the cruiser "Louisville" by two cranes of a combined capacity of only 80,000 lb. was a feat recently performed at the Puget Sound Navy Yard

Sliding the boiler out on ways, preparatory to hooking up with the cranes, was a delicate operation

Rehabilitating Steam Power Plants*

By C. F. Hirshfeld

Chief of the Research Department, the Detroit Edison Company

THE exceedingly rapid evolution of electric power generation is known, in a general way, to all who have more than a casual contact with it. However, even those whose daily business consists of power generation frequently fail to appreciate the speed with which we have advanced or the significance thereof. Figs. 1, 2, 3 and 4 may serve to visualize the rate of progress. The significance of the development, however, cannot be shown by such curves.

In the first three of these figures, the areas within which representative station practice has fallen are represented by cross-hatching, and an attempt has been made to indicate what might be called conservative practice or majority opinion by means of a curve drawn through each area.

The curve in Fig. 4 is similar to one that has appeared in print several times within the past few years. It represents a remarkable procession in the direction of lower thermal costs, but it appears to be approaching a point where further improvement will be much less rapid. The decreased thermal consumption is, of course, not self-justifying, because it may have been obtained with more than a compensating increase of fixed charges.

From the executive's point of view the rapid advance indicated in these figures has had two opposing results. On the one hand, the total cost of producing power has been decreased. On the other hand, the rate of

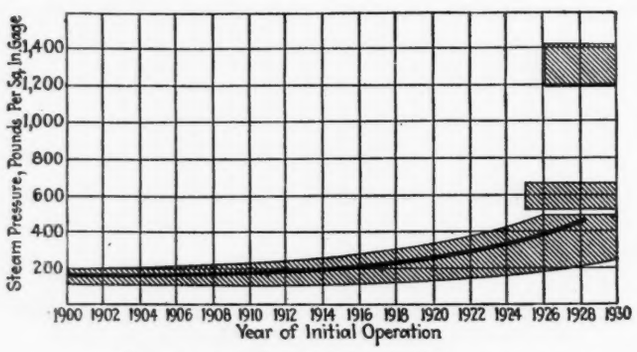


Fig. 1—Increase in steam pressures
Shaded areas indicate approximate limits of central station practice.

obsolescence has been high, and invested capital has therefore been impaired. The net result of all the forces concerned has been a gradual but consistent lowering in the price of power. But the decrease in this price naturally has not been as great as it would if it had been possible in some magic way to wipe out of existence the older and less efficient plants as more modern ones became available.

The situation from one point of view is shown in Fig. 5. The solid line represents the thermal performance for a typical metropolitan system in which the rate of growth has been rapid. The dotted line shows

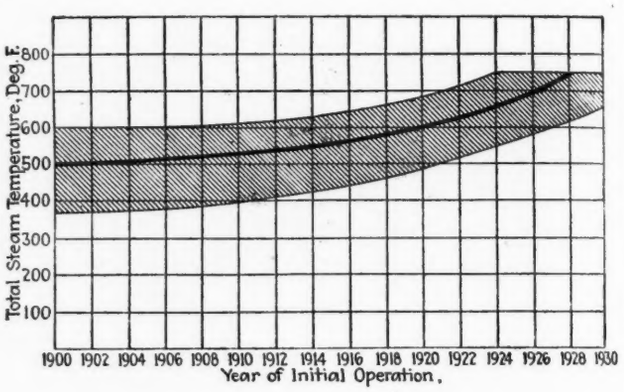


Fig. 2—Increase in total steam temperature
Shaded areas indicate limits and solid curve conservative practice.

what the values would have been if, at the time of each improvement, all earlier equipment could have been junked and the required capacity obtained with equipment similar to that just installed. One of the problems of the executives of light and power companies is to determine from time to time just how far they are justified in moving values such as those shown by the solid lines nearer to those shown by the dotted ones. It is out of this problem that rehabilitation and reconstruction of power plants result.

There is one interesting aspect of the problem which should be mentioned at this point. Let us assume an electric light and power company starting new with a 25,000-kw. power plant which cost $100 per kw. of capacity, representing a total investment of $2,500,000. Let us also assume that the entire cost of the property of the company, including the plant, is two and a half times the cost of the plant; namely, $6,250,000. If we assume that this company experiences a rate of growth of 10 per cent per year, which is quite conservative for the period of the past 20 years, it will have become a 65,000-kw. company at the end of ten years and a 170,000-kw. property at the end of twenty years. If we assume that investment has increased in direct proportion, the power plant will have cost $6,500,000 by the end of 10 years and $17,000,000 by the end of 20 years. The system as a whole will represent over $16,000,000 at the end of ten years and well over $42,000,000 at

*Excerpts from a paper presented at the summer convention of the A.I.E.E., Swampscott, Mass., June 24-28, 1929.

the end of twenty years. It may be remarked here that there are many systems in which the rate of growth has been from one and a half times to twice the rate here assumed.

Inspection of these figures shows immediately that the original investment in the power plant becomes in a few years a very small part of the current power plant

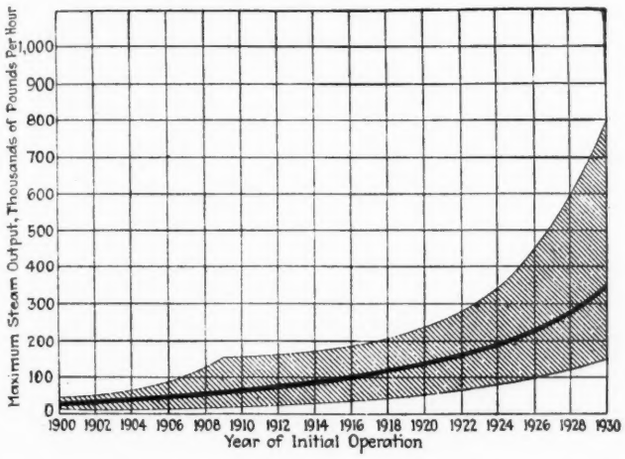


Fig. 3—Increase in steaming capacities of boiler units
Shaded area indicates approximate limits of central station practice.

investment and a much smaller part of the total current investment. When it is realized that extensive power plant rehabilitation can frequently be effected while preserving from 30 to 60 per cent of the original investment it becomes evident that such rehabilitation in a case of the sort assumed need not affect so great a part of the total capital as to represent any particular difficulties with respect to adjustment of the capital account out of reasonably small reserves.

It is self-evident, however, that no simple rule can be set as a criterion for the advisability of such operations. There are too many divergent factors. While the old rule to the effect that an improvement must at least so reduce production costs as to balance resultant capital costs holds in a general way, there are frequently many almost immeasurable, although very tangible, factors that enter the problem, so that judgment must to some extent take the place of exact calculation.

Consideration may now be given to some of the things which cause rehabilitation or even complete replacement of power plants:

1. The plant may be thermally inefficient in comparison wtih current standards of performance. This consideration is generally significant when the plant in question represents a large part of the total generating capacity and therefore a large part of the investment; when it occupies a strategic position in the system with respect to receipt of fuel or distribution of load so that its extensive use is required; when it occupies land which has appreciated greatly in value so that the maximum of return must be obtained from it, if it is to be retained; and, in general terms, under any other conditions which make the cost of fuel at this plant a very significant part of the company's annual expenditures.

2. The plant may be inefficient in the use of man power. This consideration is generally not of itself a decisive one, but is one that is taken into account in combination with others. It is serious in cases where labor trouble is to be expected and it may be serious when the plant in question represents a very large part of the total plant capacity.

3. The plant may be inefficient in its use of ground area. This becomes important in the case of land which has appreciated greatly in value, when the plant is particularly favorably located with respect to water or fuel supply and when the load conditions in adjacent territory make greater generating capacity on the site imperative.

4. The plant may be inefficient in its use of invested capital, as by occupying a larger building than necessary, operating boilers at low steaming rates, etc. This consideration is of importance only when the plant represents a moderately large part of the total plant investment or when the location becomes of particular importance for reasons such as those given in preceding paragraphs.

In the rehabilitation of a station it may be possible to do much that will result in improvement of the thermal efficiency even though the original steam pressure must be retained.

The decision with respect to the use of higher steam pressure is not entirely confined to its effect upon the thermal efficiency, because increased capacity can be obtained in this way through the use of comparatively small high-pressure turbines discharging into the old turbines, utilizing the old condensers. Therefore, while the boiler room investment would necessarily be high, this may be balanced by a comparatively small turbine room investment. The use of the old generators would also, in general, make it possible to use the old switching equipment, although there would naturally have to be additions to take care of the generators of the new high-pressure turbines.

Only one case is known to the author in which complete replacement of old boilers with new high-pressure boilers has been decided on. This is a very special case in which new boilers and turbines are being installed in the old buildings for the primary purpose of obtaining greatly increased capacity from a given site of restricted area. If it is a fact that this is the only case of this

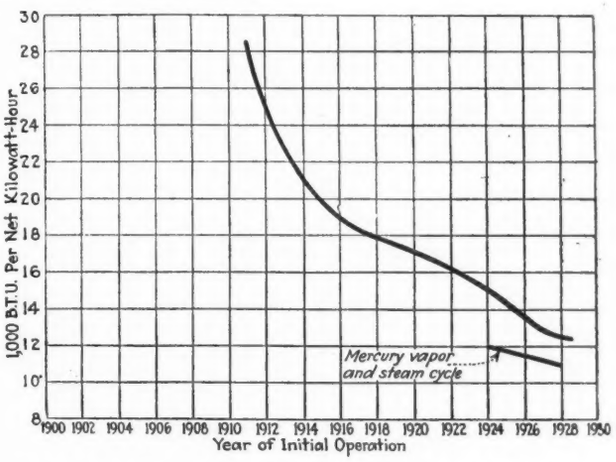


Fig. 4—Thermal economy of plants operating on 50 to 60 per cent annual load factor

sort, it may be due to the comparative newness of high pressures. There are, however, several cases in which high-pressure boilers and corresponding turbines have been added to existing stations with the idea that they would carry the base load and thus take maximum advantage of the higher thermal efficiency produced. Such

work is more properly regarded as extension of an existing plant than as rehabilitation of an old one.

The majority of cases of rehabilitation have thus far fallen into the class in which the old boilers are retained, thus accepting the limitations set by the original steam pressure. The following methods of attack are available in such cases:

1. The boiler room efficiency may be greatly improved without materially increasing the steam generating capacity. This can be done by the use of more

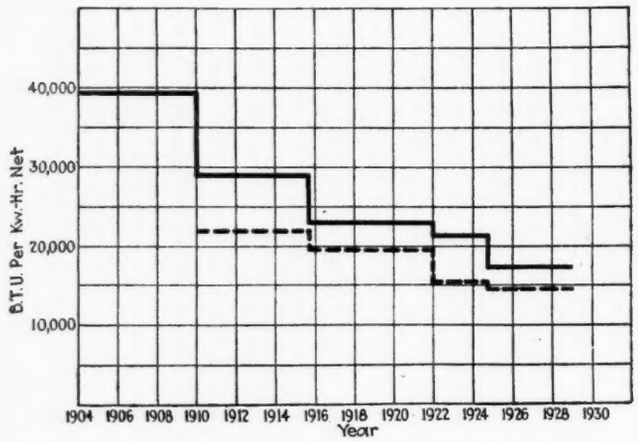


Fig. 5—The effect of additions to generating capacity on thermal economy of a representative generating system

The solid line indicates actual conditions while the dotted line shows the thermal economy which would be attained if the older parts of the system were replaced by equipment on a par with the most modern section.

modern fuel-burning equipment, by the addition of economizers or preheaters or both, and occasionally by improved baffling of the boilers.

2. The boiler room efficiency may be greatly improved and at the same time the steam generating capacity may be increased to a very great extent. It is not at all impossible to double or more than double the steam output of an old boiler room by using improved combustion equipment of greater fuel-burning capacity, while at the same time bettering the boiler room thermal efficiency. In the latter event it will generally be found advisable to use a certain amount of furnace wall cooling to gain the increased output most easily and so to hold in check the tendency toward increased furnace maintenance. In this connection it should be noted that it is frequently possible to obtain greatly increased furnace volume by ignoring existing floor levels and by utilizing modern ash-handling equipment, which requires small height for its installation.

3. The turbine room efficiency may be increased by raising the steam temperature. This will naturally involve more superheater surface or, at least, differently located surface. In most cases the use of some sort of radiant superheater in series with the older superheater will be found advantageous, but a careful study of the pressure drop through superheaters and connections must always be made. The adoption of higher superheat will usually involve minor rebuilding of the high-pressure end of the turbine, and, in some cases, major rebuilding of that end.

4. The turbine room efficiency and capacity may be increased by several different methods. The most obvious, but also usually the most expensive, is by the installation of newer, larger and more efficient turbines taking steam at higher temperature from a boiler room of increased steaming capacity. When this method is adopted it becomes comparatively easy to introduce regenerative feed heating, because the new turbine casings will be supplied with bleeder outlets. The improvement of thermal efficiency obtainable from regenerative heating can therefore be obtained readily. Larger condensers or additions to existing condensers may have to be provided. The old electric switchgear can sometimes be used by adopting a double winding on the generators so that the capacity per switch is held within the old limitations.

A less obvious but very effective method of obtaining increased capacity and efficiency is found in the compounding of old turbines with new turbines. At first glance it would appear as though this would be impossible without raising the steam pressure. This is not the case. Two old turbines may be rebuilt to receive steam at lower pressure and temperature than they did before and thus to serve as low-pressure elements to a single new turbine taking steam at boiler pressure. In such cases the extent to which regenerative heating of feed can be obtained will depend upon the design of the casings of the original turbines; naturally the new turbine can be designed for bleeder nozzles and the exhaust connection between it and the older units can be tapped for feed heating. This general method can be made to yield an increased generating capacity of at least 50 per cent and a marked improvement of over-all efficiency as well.

Rebuilding Turbines and Generators

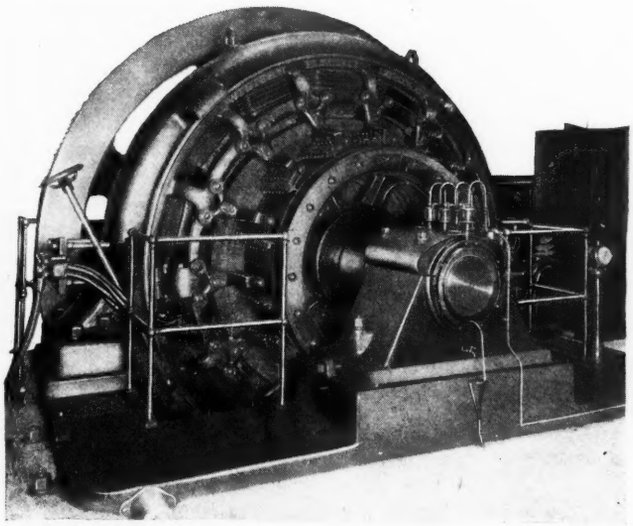
Even when neither of the methods just considered is available frequently it is still possible to obtain increased output by the rebuilding of old turbines and generators. No exact values can be given, but increases of the order of 15 to 20 per cent and occasionally even more can be obtained in this way while at the same time materially improving the over-all thermal performance of the station.

5. Even though it prove economically undesirable to replace or to rebuild the old turbines, it is still frequently possible to obtain marked thermal improvement in addition to that which can be obtained in the boiler room. This can be done through modification of the auxiliary power supply and the heat balance of the station. One is inclined to think of regenerative feed heating as necessarily tied to the bleeding of each main unit. In fact, it is obtained to a certain extent whenever that steam which is used for heating feed-water has done useful work before being used for that purpose. From the thermal standpoint it is most perfectly obtained when the steam has done the greatest amount of work before being used for heating and when the heating is done in the greatest number of temperature steps. Two, or, at the most, three, steps will ordinarily prove economically the best with moderate steam pressures such as one would expect in plants now being rehabilitated.

It is true that some executive engineers do not accept rehabilitation as economically justifiable on their own systems. Therefore, it is not legitimate in all cases to predicate original station design on the assumption that rehabilitation will be a necessary part of the history of the plant. However, such rebuilding to a greater or lesser extent appears to be becoming more general than it once was and the history of any given system with respect to such practices should be given serious study when designing new plants for that particular system.

Making D.-C. Generators Build Up Voltage

By M. E. Wagner
New York City



Corliss-engine-driven generator rated at 400 kw. and 240 volts

When a Direct-Current Generator *fails to build up voltage the engineer may find himself in an embarrassing position unless he knows how to go about correcting the difficulty. Simple tests are given that when applied lead systematically to the source of trouble*

DIRECT-CURRENT generators have their shunt-field winding connected directly across the armature, as in Fig. 1, therefore depend upon armature voltage to supply the magnetizing current. Once the field poles are magnetized they will retain a small percentage of the original magnetism even when no current flows in the field coils, as when the machine's armature is not rotating. This small magnetic field retained by the field poles is known as residual magnetism and is depended on for the machine to start building up its voltage.

With the shunt-field coils disconnected a direct-current generator will produce about 5 per cent normal volts on the residual magnetism in the field poles. On a 120-volt machine this will equal about five volts and on a 240-volt machine about 10 volts. With the shunt-field winding properly connected, the voltage produced by the residual magnetism causes a small current to flow through the field coils, which in turn causes an increase in field strength. This increase in field strength produces an increase in voltage, further increasing the voltage of the machine. This process continues until the voltage reaches a value determined by the field poles becoming saturated or by the resistance of the field rheostat.

There are many reasons why a generator may not build up its voltage. The causes may be different for a machine that is being put into service than for one that has been in operation. Among other reasons for a machine that is being started for the first time not bulding up, is wrong field connections. There is a fixed relation between the shunt-field connections to the armature and the direction of rotation. If this relation is not satisfied the machine cannot build up.

For example, in Fig. 2, assume that the polarity of the residual magnetism is that indicated by N^1 and S^1. Also assume that when the armature revolves its polarity in as shown. The voltage of the armature causes a current to flow in the field coils, as shown by the arrow heads. The current has a direction that tends to produce a field polarity, denoted by N and S. This is opposite to the polarity of the residual magnetism, and instead of the voltage increasing it will decrease.

One might assume that if the residual magnetism were reversed in the pole pieces the machine would build up its voltage. Fig. 3 explains what will happen. Reversing the polarity of the residual magnetism in the pole pieces will cause the polarity of the armature to be reversed as shown. Reversing the polarity causes the current in the field coils to flow in the opposite direction to that in Fig. 2 and tends to produce a polarity N and S in the field poles, which is opposite to N^1 and S^1 of the residual magnetism. Consequently the voltage will tend to decrease instead of increase, as explained in Fig. 2.

If instead of reversing the polarity of the field poles, as in Fig. 3, the field-coil connections to the armature are interchanged, as in Fig. 4, the field coils will have the same polarity as the residual magnetism. Under these conditions the field coils increase the strength of the field poles and the machine builds up its voltage. After the armature and shunt-field coils have been connected in the correct relation the machine should build up its voltage irrespective of the field-pole polarity. For one polarity of the residual magnetsm in the field pole a certain voltage polarity will be produced in the armature. Reversing the field-pole polarity of the residual magnetism will change the polarity of the armature.

When starting a generator for the first time it will probably be found that the field poles are dead. This will be indicated by a voltmeter showing zero when connected to the armature terminals. If a portable voltmeter is available it is well to connect it directly to the brushes, as a check on the switchboard voltmeter, and to make sure that the connections are complete to the switchboard in-

strument. If the portable meters showed the machine up to voltage and the switchboard voltmeter indicated zero it would then be known that some fault exists between the generator and the switchboard.

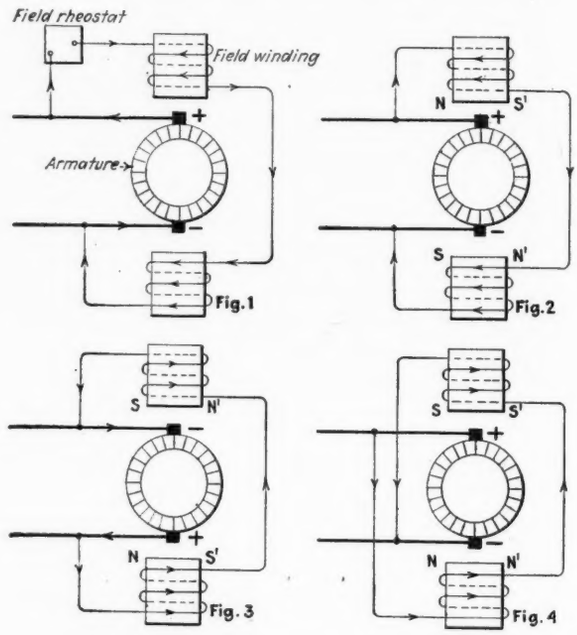
If the voltmeters indicate zero it would show that the field poles were dead and should be excited from an outside source. If a source of power having the same voltage as the machine is available, then the field coils may be connected to it. A good way of doing this is to shut the machine down, disconnect the shunt-field coils from the armature and connect them to the power source. Then, start the machine and let is revolve slowly. If the machine connections to the switchboard have been made correctly the voltmeter needle should be deflected. In case the voltmeter needle moves backward off the scale, the machine should be shut down and the connections to the field coils reversed. This will give the correct deflection on the voltmeter when the machine is again started. With the machine revolving slowly note its action. If it shows no sign of heating and does not spark at the brushes the speed may be gradually increased until normal voltage is obtained.

By starting the machine in this way a number of conditions have been checked. First, it has been established that the field-coil circuit is complete. The polarity of the field poles is made to give the generator the correct voltage polarity. It is also shown that the generator is connected to the switchboard correctly.

After the generator has been made to build up by separate excitation, it should be shut down, the source of outside excitation disconnected and the field coils connected to the machine and again started. If it does not build up its voltage, open the field circuit and note if the voltage generated on the residual magnetism increases or decreases. On a 120-volt machine this residual voltage should be about 5 volts with the field circuit open. If when the field-coil circuit is closed to the armature the voltage has a tendency to decrease to zero, it is an indication that the coil leads should be interchange. That is: If they were originally connected as in Fig. 2, they should be crossed as in Fig. 4.

If the generator does not build up now it may be that the brushes are not making a good contact on the commutator. These should be inspected. If there is any doubt about them the commutator should be cleaned and the brushes carefully fitted. The field circuit includes a field rheostat, which may be open circuited. If turned to the position where all the resistance is out of circuit the machine should build up its voltage. Failing in this, it may be well to again apply separate excitation. But this time include the field rheostat in the circuit.

If Fig. 5 shows the way the machine was connected for self-excitation, Fig. 6 indicates how separate excitation should be applied and the machine started. In case the field circuit is complete the generator should build



Figs. 1 to 4—Simplified diagrams of generator connections

up its voltage. If it does not it shows that there is an opening in the wiring to the field coils, which would be indicated by the absence of a spare when the circuit is opened.

Assume that the generator comes up to voltage, then the field rheostat can be tested by turning it to the position where all the resistance is in circuit, as indicated by the position of lowest voltage. If the rheostat is not defective the voltage should decrease gradually as the resistance is cut into circuit. Arcing at the rheostats contacts or a sudden change in voltage would indicate a defect either in the rheostat's contacts or resistance.

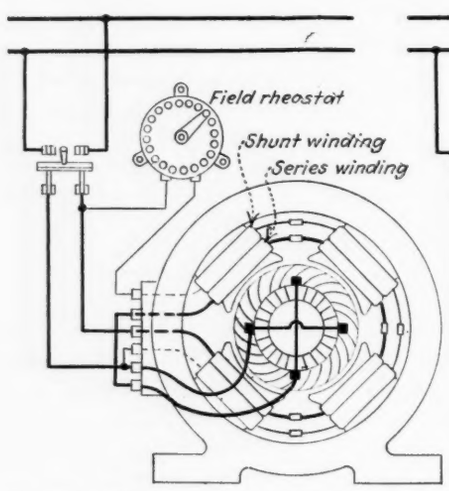


Fig. 5—Diagram of compound generator connections

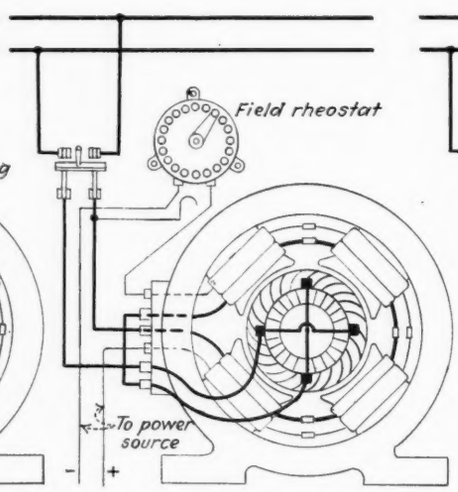


Fig. 6—Connections to separately excite the shunt coils

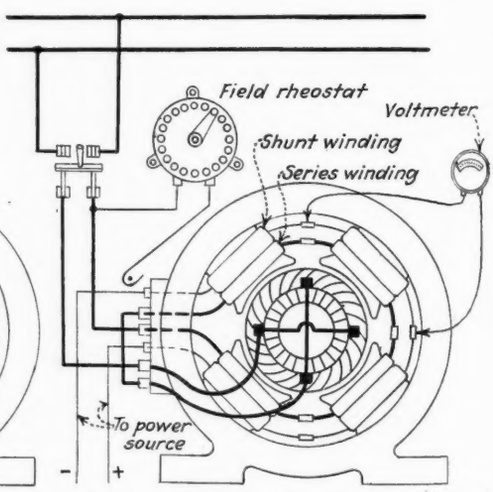


Fig. 7—Shunt coils being tested with a voltmeter

When it has been established that this part of the equipment is in good condition the field circuit should again be connected to the armature and the generator tried as a self-excited machine.

Assume that the machine comes up to voltage. When the voltage is adjusted to the proper value the load should be gradually applied. Most generators are compound wound, as in Figs. 5 and 6. In order to maintain the voltage nearly constant the series winding must have the same polarity as the shunt coils. A large decrease in voltage as the load is increased would indicate that the series-field-coil polarity opposed that of the shunt coils. When the machine is of small capacity the polarity of the series coils can be tested by short circuiting these coils with a piece of copper wire. If the voltage rises when the coils are short circuited it indicates that these coils are of an opposite polarity to the shunt coils.

Crossing the series-field-coil leads will correct the reverse-polarity condition. On some large machines the series field-coil leads are made of copper bars, or one lead is brought out on each side of the machine. In either case the leads cannot be crossed. To correct the polarity of the series field coils under this condition, shift the brushes one pole-space and cross the shunt-field-coil leads. This will bring the series and shunt field coils, on the same pole piece, of the like polarity, without reversing the polarity of the machine.

Three-Wire Generators

On a three-wire generator the series winding is divided in half, with the armature connected in between. On these machines cases have been recorded where one-half of the series coils were of the same polarity as the shunt coils and the other group had opposite polarity to the shunt coils. Under this condition the generator would have about the same voltage characteristics as a simple shunt machine, that is, the voltage would drop as the load increased. However, crossing the leads on both groups of series coils will not correct the trouble, as was tried in one case in mind. The proper procedure is to cross the leads on one group of series coils and try the machine with load and note how the voltage holds up. If the voltage is more constant than before the change, it indicates that the polarity of the group of series coils has been made the same as that of the shunt coils. If the voltage is caused to decrease more than before the change, it is known that this group of series coils has been made to oppose the shunt coils and should be changed back to the original connections. After this group of series coils has been connected correctly the other group of coils should be checked.

On a two-wire machine there is a possibility of the series coils not having the correct polarity. A case cames to mind where, on a large machine, several of the series coils were connected so that they did not check out alternate *N* and *S* poles. This condition caused poor voltage regulation and sparking at the brushes. To check the series coils for polarity connect them to a source of power through a water rheostat and adjust the flow of current to a value that will establish the polarity of the polepieces, and test the polarity of the poles with a compass.

Any of the foregoing conditions, with the exception of wrong shunt-field connections, may exist on a machine in service. After a machine has been in operation and fails to build up its voltage the trouble may be due to open field circuit, which may be in the field coils, in the coil connections, in the field rheostat or in the wiring. Short circuit in the coils, grounded field coils, brushes making poor contact with the commutator, short circuit of the generator leads, short circuit in armature coils, loss of residual magnetism, brushes off the neutral position—are other causes that should be checked when a generator fails to build up its voltage.

To test the shunt-field coils, connect them to a source of power, as in Fig. 7, and with a voltmeter measure the voltage across the terminal of each coil as indicated in the figure. If one of the coils is open circuited the voltmeter will indicate zero until connected to the defective coil, when a reading equal to line voltage will be had. When some of the coils are short circuited the voltmeter will give a high reading on the good coils and a low reading on those that are defective. Grounds in the field coils may be checked by the usual lamp test.

Annealing Monel Metal and Pure Nickel*

WHILE more care is necessary in annealing Monel metal or pure nickel than is required for heat-treating steel there is nothing unusual in the principle. Either open or closed (box) annealing may be used, but it is essential that variation in temperature, furnace atmosphere time etc., be controlled within close limits.

Sheet-metal products, such as hollow-drawn ware or stampings, of Monel or pure nickel are best annealed by the open methods. The material is heated in a sulphur-free atmosphere to a temperature in the range of 1,650-1,750 deg. F. for five to ten minutes. It is then removed and quickly plunged in a quenching mixture of one part of wood alcohol in 80 parts of water. Handling should be arranged so that the article enters the bath still at a bright yellow heat. It should be allowed to cool for a few minutes in the quenching bath before further cold working.

After annealing, the metal is softened so that it can be redrawn in presses or reworked by cold spinning or hammering. This method will leave a white oxide surface on pure nickel, and a copper colored film on Monel metal. Pickling or buffing may be necessary to remove this film.

Where it is desired to protect the surface from oxidation, the annealing may be done in cast-iron or steel boxes through which gas is passed to maintain a reducing atmosphere.

The difficulty of box annealing is the fact that great care must be taken to avoid too prolonged heating, which will cause a coarsening of the grain and a loss in ductility. The box must, however, be held at the annealing temperature for sufficient time to insure thorough heating, and Monel metal and nickel products should be kept between 1,425 and 1,550 deg. F. for from six to ten hours to get the best results in ductility and softness. If the temperature is allowed to run above the limit given, heating time should be reduced. At 1,650 deg. the most satisfactory result will be obtained in 1½ to 2 hr. Before the covers are removed cooling should continue in the boxes until the charge is below 300 deg.

Salt-bath annealing will be found advantageous for hot-rolled products where a combined effect of annealing and pickling is desired. A molten bath of sodium and potassium chlorides to which one or two per cent of calcium chloride has been added will give best results, provided it is free from sulphur.

*From a Bulletin of the International Nickel Company.

Maintenance Work and Inspections Should Be Scheduled

Waste of effort and time, and consequent lower economy, can be avoided by the use of some method of scheduling work and inspection and of reporting on the fulfillment of such schedules. In this article Mr. Polakov outlines a standard method that has proved successful in practice.

By Walter N. Polakov*
Consulting Engineer, New York City

With the use of a proper schedule of maintenance work it is possible to do more work with less men and without interruption to service. The jobs are done in order of sequence and at a time when the unit is available for inspection, overhauling or cleaning. Prearranged periodic inspections and minor repairs greatly minimize hazards of break-down, which might require straining of all resources and often extra men taken away from other jobs to do a rush repair that, incidentally, is never high-grade work.

The power plant maintenance man lays out the maintenance schedule in agreement with the chief engineer or power plant superintendent.

Work Schedule Chart

Planning of Jobs: Each job on any unit of equipment is listed on one harizontal line of the chart shown in Fig. 1, whether time is assigned or not.

Schedule Time: Seven vertical columns represent days of a week, dates appearing on the top. Time during which the job is to be done is represented between the angles by a thin black line in the upper space for the days during which the job is to be done.

Time Taken: The lower section for each day is for record of jobs actually in progress. Time actually taken is shown by a heavy line (in lower section) extending over the days actually consumed on the job. Line is extended from day to day until work is finished and approved, and unit is ready for use; then the line is ended by a small vertical bar.

Less-Than-One-Day Jobs: Are marked as above either in the first or last half of the section, indicating A.M. or P.M.

Overtime or Night Work: If the work was carried on overtime or during the night, one and a half or two heavy lines, one on top of another, are drawn for the time the job was in progress.

By Whom Done: If the work is done by the maintenance man, no other notation is needed except if late in starting—see "Delays." If the job is done by outside help and it has order number assigned, same appears on top of the thin line indicating scheduled time.

Delays: If the job was not started on scheduled time, write for each day delayed the reason why, as follows:

Operation Interference	O
Material or Tool Missing	M
Labor Shortage	L
Schedule Changed by Authority	S

Interruptions: If the job in progress is interrupted for any reason at all, the heavy line is broken and the cause marked on top, using the same symbol as for causes of delay.

Unscheduled Jobs: There are always jobs to be attended to for which no definite time was assigned beforehand. These must be listed in the job column, but no schedule time line can be drawn opposite. Then, when these jobs are attended to, the heavy lines representing time taken are drawn in the regular way.

Inspection Route Card

Wandering through the plant, with the object of accidentally discovering signs of wear and tear, is a poor practice because:

1. It takes more time and covers more mileage, if done without plan than with a plan.

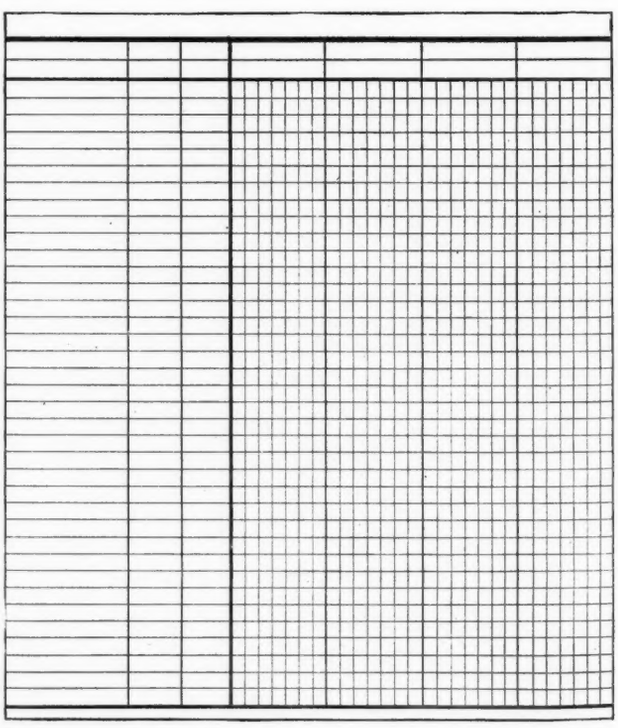


Fig. 1—Blank form for listing maintenance work, in which jobs are placed in column at left and a vertical column is available for each day of the week

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ELECTRICAL INSPECTION ROUTE CARD

Make the Following Inspections, in the Order Named

Watch 7—3 P M	EVEN SUNDAYS				
Apparatus	2	16	30	13	27
1—25-cy Gen	✓	✓			
2—No. 11	✓	✓			
3—No. 13	✓	✓			
4—No. 12	R	✓			
5—A	✓	✓			
6—B	✓	✓			
7—C	✓	✓			
8—D	✓	✓			
9—S	✓	✓			
10—CS	✓	R			
11—T	✓	✓			
12—Coal Larry No. 3	✓	✓			
13—Coal Larry No. 4	✓	✓			
14—Battery Blower	✓	✓			
15—Economizer	✓	✓			
16—Coal Elevator (Ry.)	✓	✓			
17—Coal Crusher	✓	✓			
18—Coal Conveyor	✓	O			
19—Ventilators	✓	✓			
20—Ash Locomotive	✓	✓			
21—Oil Filters	✓	✓			
22—Oil Pump	✓	✓			
23—Control Bench	✓	✓			
24—Feeder Board	✓	✓			
25—Local Ser. Board	✓	✓			
26—Exciter Board	✓	✓			
27—Signal Board					
R—Repair Suggested					
O—Ordered Out					
Signed.....	1	P			

Fig. 2—Sample of an inspection route card used in a large power plant. These cards are protected from soiling by a celluloid envelop with a slot cut in to permit marking

Inspectors make routes and attend to minor adjustment at once themselves, if O.K. they mark on the card; if repair needed R, and if it is dangerous to keep the mechanism in use they order it out—O.

2. Things can be seen if looked for, and overlooked if gazed at.
3. Gradual changes, if seen daily, are not apparent. It is hard to describe wall paper design, or the face of your watch, or note new gray hair on your own head, until your attention is called to it.

A route card planned to cover all equipment to be inspected, laid out for shortest walk, and calling particular attention to particular parts, the condition of which is to be marked at once on the card, is a remedy against oversight. When a repair is called for, the power plant clerk, upon return of the card, issues repair orders and the necessary materials.

The example of an inspection route card, shown in Fig. 2, covers the electrical equipment in an electric railway power plant, listing machinery scheduled for thorough fortnightly inspection.

WHERE PROCESS STEAM MUST BE TRANSPORTED for considerable distances it may, in some cases, be advisable to generate byproduct power from a turbine placed near the point of steam application rather than from one near the boilers. The disadvantage of decentralizing the generation of electricity may be more than offset by the saving in piping due to the higher pressure and smaller volume of the transported steam, also by the decrease in cost of insulation.

Frictionless Metallic Packing

J. T. TOWLSON

I DO NOT KNOW whether the precise design here illustrated and described is distinctly new in piston-rod packing; but I suspect that its principle cannot be new.

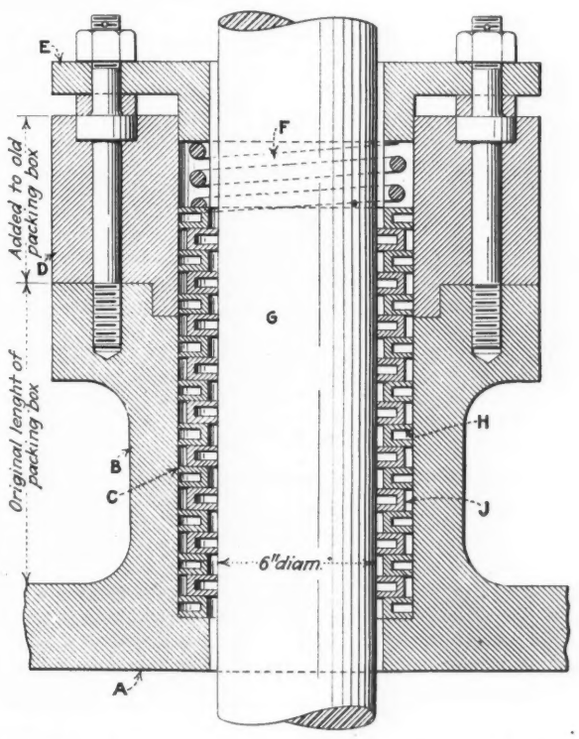
It was used for a case where the fiber packing of a piston rod of a large mill engine gave constant trouble. The rod was apparently out of line, and at times one side of the piston rod would become abnormally hot, and bend toward the heated side. This bend increased the heat, and the increased heat accentuated the bend.

Referring to the sketch: *A* is the cylinder cover of the engine. *B* is the original packing box, reboxed and ground out to a glass finish at *C*. *D* is a part added to the packing box and ground out jointly with *C*. *E* is a fixed gland which, with a helical spring *F*, holds the set of bronze rings *H* and *J* in position in the packing box. *G* is the piston rod, 6 in. in diameter—ground to a smooth finish and parallel.

It will be observed that this system of packing precludes the possibility of the packing box being a guide for the piston rod. However, the piston rod is always guided by other means and all the packing box is required to do is to prevent pressure leaking by.

This plan dispenses with all kinds of adjustable packing (fibrous or metallic). Split rings with springs, which tend to nip and wear the rod, are also dispensed with.

Dependence is placed on a considerable number of whole annular rings, one ground to fit the rod, and its adjacent follower ground to fit the packing box bore. By this means the piston rod can easily float at will, simply sliding without stress through the rings *J*, while the rings *H* prevent leakage at the bore of the stuffing box. The light gland *E* gripping the spring *F* holds the series of annular rings lightly but closely together, and the packing as a whole becomes amenable to any "out-of-alignment" of the piston rod. There is no tendency for the rod or the rings to wear unduly.



Section of extended gland, with multi-ring packing

Dissociation of Steam at High Temperatures Speeds Corrosion

WITH the continued increase in the use of higher steam pressures and temperatures, a corresponding increase in the attention given to problems of scale, embrittlement and corrosion has become vitally necessary. Formerly, interest had been centered chiefly upon impurities, and corrosion was ascribed almost entirely to the dissolved oxygen in the feed water.

The fact that, under the severe conditions of high temperature, pure water itself becomes an active corrosive agent worthy of investigation has lately been realized. At the annual convention of the American Water Works Association, recently held in Toronto, C. H. Fellows, of the Detroit Edison Company, presented a report, "The Dissociation of Water in Steel Tubes at High Temperatures and Pressures," dealing with this phase of the corrosion problem.

The presence of small amounts of hydrogen in both the saturated and superheated steam was noted by Mr. Fellows during a survey of the feed-water conditions of a new power plant. Other observations served to substantiate these findings, and as a result it was decided to make a thorough study of the dissociation of steam in contact with hot metal.

The chemical reaction taking place under conditions such as those imposed in these tests is as follows:

$$3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$$

Iron	Steam	Black Iron Oxide	Hydrogen

From this equation, if the volume of hydrogen evolved is measured, the weight of steam decomposed and the weight of iron decomposed can be calculated.

on with the steam flowing through the tubes at a rate of 0.20 lb. per minute.

It was found, the report states, that "the reaction between steam and metal proceeds at different rates depending upon the chemical composition of the metal, the condition of the surface, the temperature of the surface of the metal in contact with the steam, the moisture in the steam, and the rate at which it is passed over the surface."

The conclusions drawn by Mr. Fellows from his work are:

1. The rate of decomposition of metal increases as the temperature over which the steam passes is raised.

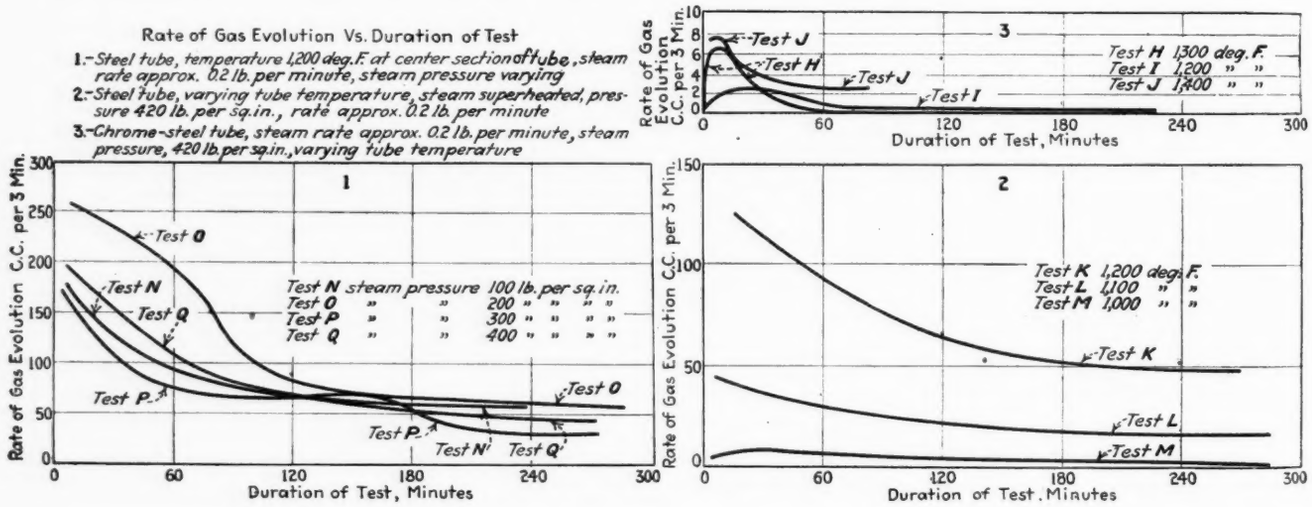
2. The rate of decomposition of metal decreases as the thickness of the oxide formed on the surface increases. There is no evidence that this oxide attains sufficient thickness or imperviousness to protect completely the metal from further oxidation.

3. For practical considerations, the variation in the steam pressure within the limits used appears not to affect the rate of decomposition.

4. The decomposition of low-carbon steel under the conditions of the test proceeds at a much faster rate than that of the chrome steel.

In adapting the results of these tests to conditions prevailing in actual practice, two important differences are pointed out in the report. In the first place, there is a considerable difference in steam velocity. In the tests, when the steam was moving at approximately 25 ft. per min., considerable corrosion took place, but at velocities of about 850 ft. per min., which corresponds more nearly to plant conditions, the corrosion is very much less. At steam velocities approximating 3,000 ft. per min. no such action was noted.

The difference in temperature is also significant, Mr.


Rate of Gas Evolution Vs. Duration of Test
1.-Steel tube, temperature 1,200 deg.F. at center section of tube, steam rate approx. 0.2 lb. per minute, steam pressure varying
2.-Steel tube, varying tube temperature, steam superheated, pressure 420 lb. per sq.in., rate approx. 0.2 lb. per minute
3.-Chrome-steel tube, steam rate approx. 0.2 lb. per minute, steam pressure, 420 lb. per sq.in., varying tube temperature
Rate of Gas Evolution C.C. per 3 Min.
Duration of Test, Minutes
Test J
Test H
Test I
Test H 1,300 deg. F.
Test I 1,200 " "
Test J 1,400 " "
Test O
Test N
Test Q
Test P
Test N steam pressure 100 lb. per sq. in.
Test O " " 200 " " " "
Test P " " 300 " " " "
Test Q " " 400 " " " "
Test K
Test L
Test M
Test K 1,200 deg. F.
Test L 1,100 " "
Test M 1,000 " "

Gas-evolution charts used in corrosion test

The tests were made on both low-carbon and chrome-steel superheater tubes, all having the same internal surface area. The tubes were electrically heated to about 1,200 deg. F., and steam passed through them at various pressures up to about 450 lb. per sq.in. Tests were made with both saturated and superheated steam. The gases carried by the steam as it entered the apparatus were determined, and then, after it had passed through the tube, the gases evolved as a result of the reaction between the steam and the hot metal were separated, measured and analyzed. Most of the tests were carried

Fellows points out. At the usual operating temperature of superheater tubes, corrosion due to dissociation would be negligible. "It is a well known fact, however," the report states, "that unburned combustible gases find their way through the various passes of a modern boiler and ignite spontaneously at points where normally no flame exists. This phenomenon has been observed many times in the superheater passes of boilers, and may offer an explanation for the actual existence, even though momentary, of tube temperatures of that order necessary to cause the dissociation of steam."

Right Out of the Plant

Cleaning Metal Parts With Acid

SOME time ago our injector refused to work. When I took off the cap at the bottom and lifted out the combining tube I found that it was almost completely filled with a sediment like soft lime. There was also considerable scale in the draft tube and in the suction chamber. I tried boiling it in hot soda water, but that would not remove it. So I diluted some muriatic acid by adding ten parts water to one part acid and put the injector in the solution for about two hours. When I took it out the metal was clean.

By making the solution of ten parts water to one of acid you can safely leave the injector in it for several hours without damage to the metal. IRA S. ELLIOTT.

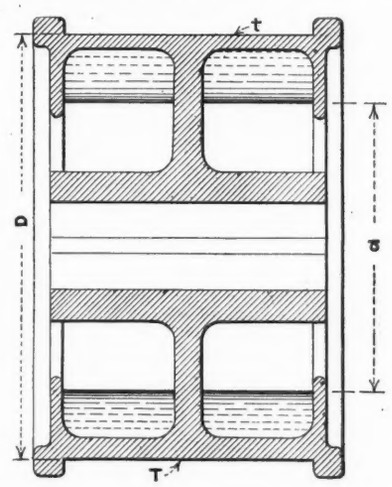
Hamilton, Ont.

Cooling Water Throws Brake Pulley Out of Balance

TO TEST machines of new design we found it advisable to build a Prony brake and to design a special steel brake pulley to use with the brake. On account of the high speed, 3,500 r.p.m., the pulley was put in dynamic balance. When the testing machine was assembled and run on light load and without any cooling water in the brake pulley, there was no vibration, showing that the pulley was properly balanced. When the load was increased, we added water to the inside of the pulley to keep it and the brake cool. This caused the pulley to be thrown out of balance, and the machine vibrated objectionably.

Two questions at once arose: Why did the water throw the pulley out of balance, and how could the pulley be put in dynamic balance to remain so when water was added. An investigation showed one side of the pulley's rim was thicker than the other. This was caused by the pulley not being finished on the inside.

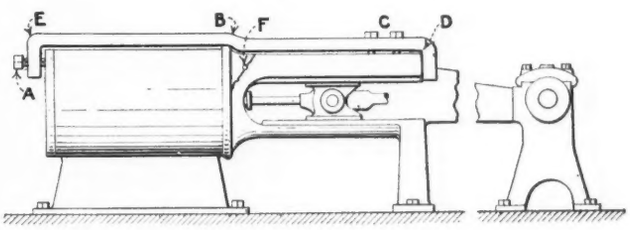
In the figure T is part of the pulley where the rim is thick and t where it is thin. When the pulley is running at high speed and water is added, the surface of the water assumes a circle, say, of diameter d, which is concentric with the outer diameter D. The thickness of the ring of water at t is greater than it is at T. Therefore, there is more water on the side of the pulley where the rim is thin than on the opposite side, where the rim is thick, and this explains why the pulley was out of balance with water in its rim.



When the cooling water was put in the rim it formed a ring concentric with the axis of the pulley and threw the revolving mass out of balance

If the pulley were machined all over on the inside as well as on the outside, making the inner circumference of the rim concentric with the outer, the addition of water would not affect its balance. Owing to lack of time and suitable tools it was found inadvisable to remachine the pulley. It was balanced with water in its rim, and the vibration ceased. I might add that only a small quantity of water need be used during the balancing operation, just enough to compensate for the unevenness of the thickness of the rim. DAVID FLIEGELMAN,

Worcester, Mass. Coppus Engineering Corporation.



How the frame was stayed

Repairing a Cracked Engine Frame

THE power plant in a box factory where I was employed as chief engineer consisted of a 500 hp. Brown engine, two return tubular boilers and a small generator. Indicator diagrams taken off the engine showed that it was developing around 450 hp. At that time business was good and the manager kept adding more machinery until the engine was overloaded. The power was transmitted from a 16-ft. flywheel to the main drive shaft in the mill by a 33-in. belt with a belt tightener on the lower side. This increased load caused an excessive strain on the frame of the engine, and one day the frame cracked, as shown at F in the sketch. The crack, which was twelve inches long, ran through two bolt holes that tied the frame to the cylinder.

The way in which the frame was repaired is shown in the illustration. A templet was made to conform to the engine cylinder and frame. Then the blacksmith forged a piece of railroad iron six inches wide and three inches thick, bent at right angles at E and D and also bent in at B. While the support was being made the millwright squared the guide at D. Two bolts at C were used to tie the bar to the frame. One cylinder head bolt was removed and the bar dropped into place. The bar was drilled and tapped at A for a $2\frac{1}{2}$-in. bolt, which was screwed against the cylinder head, thus relieving the strain on the frame where it was cracked. A hole was drilled and tapped in the crack at F for a $\frac{1}{2}$-inch stud, to keep the two edges of the crack from working. The accident happened at 2:30 p.m., and the following morning at 7 a.m. the engine was again in running condition.

North Cambridge, Mass. W. A. Dow.

Why the Compressor Belt Flapped

IN THE March 19 and April 9 numbers of *Power* there were discussions on the subject of why the compressor belt flapped. There is another condition not mentioned in either article that will cause a compressor belt to flap, and that is lack of cylinder lubrication. In this case the compressor will operate with a jerky motion. This will not continue very long, however, before the piston will seize in the cylinder, and the weakest part will let go. The usual result of this is a broken connecting rod or crosshead, and occasionally a general wreck occurs.

HOWARD LIVINGSTON.

Los Angeles, Calif.

Forecasting Stream Flow for Power Generation

HAVING had the opportunity to do a modest amount of independent investigation along the line of work done by Mr. Streiff in forecasting stream flow and described in *Power* April 16 and 30, I feel confident in saying that he has opened up some interesting possibilities that at present are little appreciated by water-power companies. I believe, however, that his article should be supplemented by a word of caution to the effect that we have still a long road ahead and that there undoubtedly will be many discouragements that may be traced, on the whole, to faulty fundamental data. Nevertheless, there is financially much at stake, and even though only a partial, or roughly approximate, solution to the problem may be possible, it should be useful as an indication of the probable future stream flow to be expected.

Attention has been called to the value of such studies for the prediction of total amount of rainfall or runoff in a given year. There are other important applications. For example, such studies would be very useful in determining the correct equalization of earnings from water-power projects to insure continuity of dividends as well as the true average runoff for periods longer than are covered by existing records.

Our interest in this subject was aroused by the opinion expressed at a committee meeting to the effect that a run-of-river plant would not be particularly interested in cyclic variation of total runoff, since the energy to be derived from the portion of the stream flow that passes through the wheels and is not spilled uselessly over the dam would depend so largely upon the distribution of rainfall throughout the year. In order to test this objection, we drew up a diagram, reproduced in the figure, which shows month by month since the beginning of 1891, the energy which the Holtwood plant could have delivered to its customers, assuming for the entire period the same load conditions and relation between river flow and daily delivered output as actually existed in 1927. It is rather surprising that variations in output bear a distinct relation to sun-spot maxima and minima in spite of the complicated relations between load, energy and usable flow, the plant operating for about 140 days each year at nearly constant output for approximately seventeen hours a day regardless of river flow. I am inclined to believe that the cause of this close agreement is not only the generally higher precipitation during years of high sun-spot numbers, but also the decreased loss from evaporation during these years.

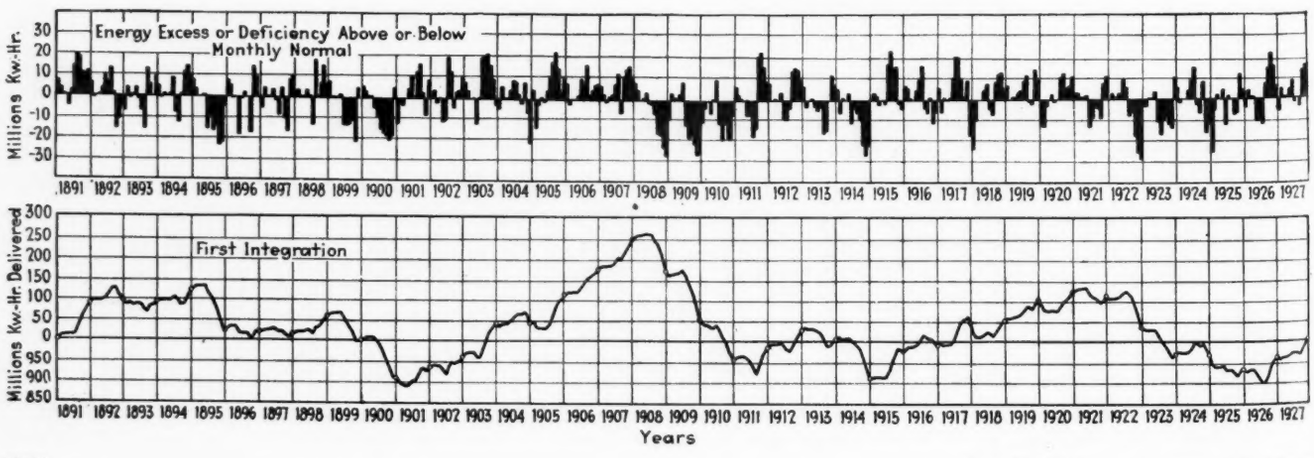
It should be emphasized that accurate records are necessary upon which to base studies of this kind. Mathematical means should be developed to test these data before using, in order to be assured that they are not subject to gross errors arising particularly from changes in methods of stream-flow and rainfall measurement from time to time. In the studies that we have made we have been especially fortunate in being able to compare and check our power-plant records with the stream-flow gaging station maintained by the State of Pennsylvania at Harrisburg.

We have found that analyses that involve comparatively simple mathematical processes can easily be applied and are adaptable to machine computation, and that they can greatly lighten the task of deriving such curves. The various experiments we have tried lead clearly to the conclusion that rainfall and runoff are by no means as accidental in nature as at first would be supposed. Care must be taken, however, to avoid false conclusions from careless analyses. I feel that one of the greatest dangers would be condemnation on the part of those who attempt the solution of this problem in a slipshod manner and fail to get the results they expect.

The subject is certainly worthy of serious consideration, and it clearly shows a need for accurate data of this kind. It may be some time before results of great practical value can be obtained, but the possibilities that are clearly demonstrated suggest the desirability of a greater degree of accuracy as well as more complete records of rainfall and run-off.

Baltimore, Md. CARROLL F. MERRIAM,
Pennsylvania Water and Power Company.

Curve showing energy excess and deficiency above and below monthly norm at the Holtzwood plant and the first integration of this curve



Safety Should Be Made a Feature of Design

WHEN you broached the subject of "Safety Should Be Made a Feature of Design" in the March 19 number, you placed your finger on a very important matter and one that is too often ignored. Too many executives seem to think that "safety first" pertains only to the operation of a plant, where, as a matter of fact, "safety first" starts with the design and installation.

The increasing use of pulverized coal, together with oil, has introduced a number of hazards that are frequently overlooked. In other instances, they have been stressed to an extreme, and so of themselves increase the hazards to ignorance or exaggeration. That oil and powdered coal have brought about increased hazards is stressed in an editorial in the Feb. 26 number on the subject of "Pulverized Coal Furnace Explosions." As pointed out in this editorial, furnace explosions are more numerous than is generally supposed. It is also true that many lesser "puffs," or "flare-backs," are taking place which are not large enough to warrant the term "explosion" but which are more or less serious.

I am familiar with a powdered-coal-burning plant consisting of three unit pulverizers where trouble has been encountered due to the burner clogging up and with the necessity, therefore, of loosening up the mass and getting the furnace going again. This is a condition the men dread. While too much care and plenty of fear are vastly preferable to bravado and carelessness, the interests of all concerned would be furthered if the manufacturers of coal-burning equipment were to have printed instructions posted in prominent places stressing the dangers of powdered-coal explosions and asphyxiation.

That pulverized-coal-furnace explosions are taking place not as a rarity from time to time but fairly frequently is well emphasized by the fact that one insurance company is now furnishing protection against furnace explosion. This insurance covers, of course, volatile coals, powdered coal, oil and gas. This insurance is, however, strictly a furnace-explosion insurance, embracing explosions in the tubes, flues and other passages used to conduct the gases from the furnace to the stack. A bulletin issued by the Bureau of Mines on this same subject contains much valuable information for the executive desiring to protect his men and equipment and for the engineer desiring to protect himself.

A naked flame or spark in the presence of an explosive mixture is apparent, hence recognized. What is overlooked is that the real danger of asphyxiation due to carbon monoxide gas is also always present. This danger is rarely mentioned with regard to the dangers of powdered-coal-burning plants. Nevertheless, it is real and ever-existent, and men have lost their lives in powdered-coal-burning plants from this cause.

The presence of carbon monoxide gas should be suspected in every pulverized-coal-burning plant, in every storage bin and other closed places. In many plants the atmospheric temperature is sufficiently high to cause the powdered coal to give off gas. For this reason men working adjacent to powdered coal in storage, in movement or in spaces where gas can collect should be warned against the hazards and provided with the means of combating them.

Men sent into the bins to clean them out and wipe off all surfaces so as to minimize the possibility of explosions become subject to whatever carbon monoxide gas is present.

Where men are to do cleaning, repairing and general overhauling in storage bins for powdered coal, etc., special precautions should be taken to see that all such spaces are thoroughly ventilated before the men enter. Adequate ventilation should be maintained as long as the men are at work. If necessary, a forced-draft blower should be used. Self-contained oxygen-breathing apparatus or a hose mask may be indicated to be supplied to each worker where adequate ventilation cannot be maintained. A further precaution would be to tie a rope around each man's waist or beneath the armpits, so that if necessary he can be pulled out in case of unconsciousness. At least one man should be kept outside the bins whose sole duty is to watch the worker in the bin below and render help if required.

That more accidents do not occur from either condition is surprising. Analytical visits to powdered-coal-burning plants, talks with the men and study of the conditions show that it is a matter of luck rather than of prevention by design or familiarity with the dangers among the men through education. As pointed out in the editorial, safety methods and precautions should start with the design. However, the hazards referred to in the foregoing involve personnel as well as equipment. The price of safety is eternal watchfulness against recognized dangers. The responsibility for developing this watchfulness devolves upon the management, and it would seem that the manufacturers of powdered-coal-burning equipment have been lax in stressing the dangers involved and in impressing them upon the management so that they, in turn, may impress them upon their personnel.

There have been enough accidents already to enable those who know and those upon whom rests responsibility, to formulate their precautions and stress the conditions to be guarded against, both in plant design and in operation. All that remains, therefore, is to drive home the importance of these precautions and to place them vividly before those whose lives are at stake and in whose safekeeping rests the safety not only of human life, but of valuable equipment. It behooves those who know, to show the way. The need for it is apparent. The time for it is now.

Chicago, Ill. I. L. KENTISH-RANKIN.

[The editorial to which Mr. Kentish-Rankin refers specifically pointed out that most of the recent pulverized-coal explosions were attributable to carelessness in operation rather than to design.—Editor.]

Winnipeg Has High Per Capita Consumption of Electricity

IN THE Spot News column of the July 9 number there is a paragraph on Chicago in which you quote a statement by Dr. Adolph, of Berlin, that Chicago is leading the world in per capita use of electricity. This is given as 1,088 kw.-hr. for the year 1927.

I should like to point out that in the city of Winnipeg proper the consumption per capita, exclusive of the street railway load and any large power loads outside of the Greater Winnipeg district, was 2,512 kw.-hr. per capita.

Including the street railway load, large paper mill and other industries in the suburbs, the total consumption for the year 1928 was 3,015 kw.-hr. per capita.

Manager Electric Utility.

Winnipeg, Man. E. V. CATON,

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

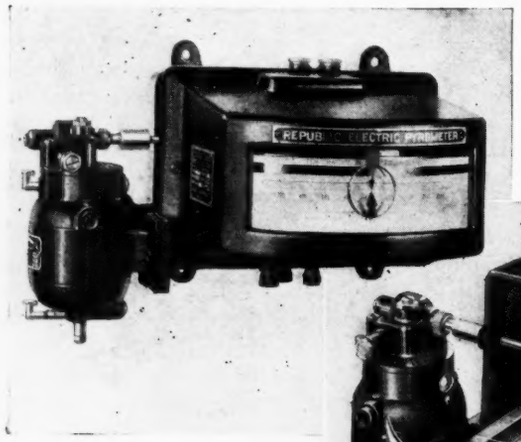
Control Pyrometer With Motor-Driven Depressor and Mercury Switch

A NEW combination of pyrometer control apparatus and mercury switch designed specifically for the control of electric furnaces and any type of fuel-burning furnace has been brought out by the Republic Flow Meters Company, 2240 Diversey Parkway, Chicago. The new combination may be applied to other control applications, to draft, pressure, etc. The outstanding feature of the control lies in the elimination of the usual open metallic contacts and the relays that previously have been required for controlling electrical loads of any magnitude. A gas-filled mercury switch is used that will handle currents up to 25 amp. at 220 volts. Above ten amps. the switch uses a mercury-to-mercury contact and the make and break occurs inside of a quartz tube, which is insulated from the glass sealing tube. These switches may be placed in series with any controlled circuit and will make and break indefinitely. The illustration shows the instrument with and without the front cover, the latter view showing the working mechanism of the control, and the mercury switch at the right.

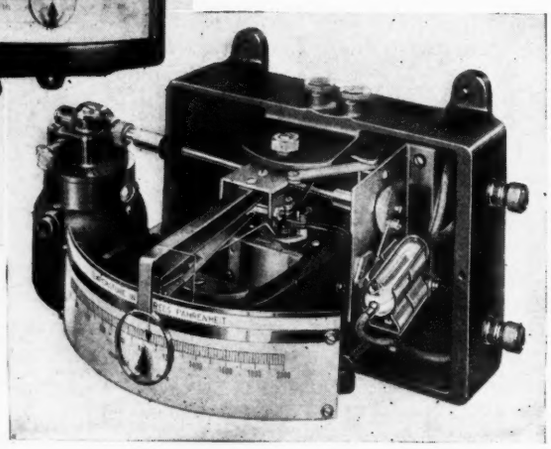
The pyrometer is of the standard Republic high-resistance, double-pivoted millivoltmeter system. The control mechanism is a purely mechanical device that might be described as a "selector" system or as a reversing clutch system. It consists of a small synchronous motor operating by a simple mechanical motion in such a way that the position of a power lever is determined by the position of the sensitive pointer. A thermocouple is used to operate a millivoltmeter movement in the instrument. When the needle corresponds with the control point, which is set on the indicating dial by means of a target, the depressor mechanism, operated by the small synchronous motor, is not permitted to descend on its periodic depression.

A crank arm direct connected to the motor lifts the lever that throws the switch on and off. This crank arm is guided by a selector cam, whose position is in turn determined by the position of the depressor. When the temperature is below the given setting, the depressor passes the pointer on its downward stroke and sets the crank arm so that it turns the switch on. The switch then remains in this position until the temperature rises and the pointer intercepts the depressor, preventing it from completing the downward stroke. The crank arm then takes a different position and operates a trip lever that throws the switch off. The action is positive and continuous and the frequency of the motion of the depressor can be made to fit the needs of the application.

It will be evident that the millivoltmeter is not required to do any work other than to move the light pointer, while the position of the pointer causes the synchronous motor to trip the switch. The instrument has automatic cold junction compensation and is available with various scales up to 3,000 deg. F. Depending upon the temperature range, it may be used with either noble or base metal couples.



Pyrometer (below), with casing removed to show operating mechanism



Control pyrometer (above), with motor drive to operate depressor mechanism.

Underfeed Stoker for Small Boilers

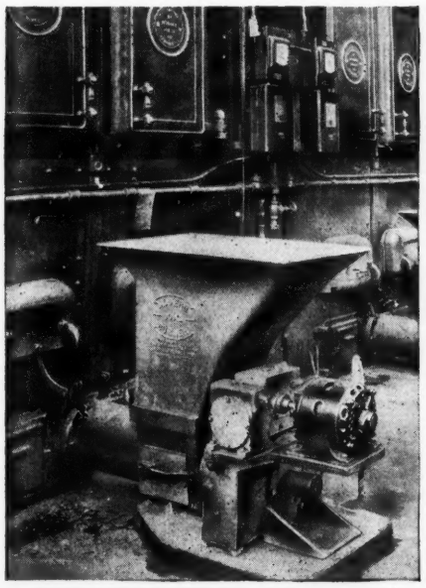
IN THE May 15, 1928, number of *Power* the underfeed stoker for small boilers put out by the Modern Coal Burner Company, Chicago, Ill., was illustrated and described. Since that time several important improvements have been made to the stoker, which have resulted in reduced maintenance and improved operating results. These improvements include a new design of motor drive and control and the adoption of interlocking deadplates at the sides of the retort.

The stoker, which is a single-retort unit, is adaptable to practically any type of boiler generating from 500 to 6,000 lb. of steam per hour. The retort is made in three sizes, with 24, 36 or 48 in. of tuyere length, and the over-all retort assembly in the firebox in each case approximately 20 in. longer. Maximum coal-burning capacities are, respectively, 400, 700 and 1,000 lb. per hour.

The deadplates at either side of the retort, which receive the ash and carry it to the furnace side walls, are now made with interlocking sections instead of one section, as formerly. The ashes are removed

through a fire door at each side of the furnace front.

To give plenty of room for this purpose, or for hand firing in an emergency, the screw-feed conveyor is extended to a feed hopper twenty



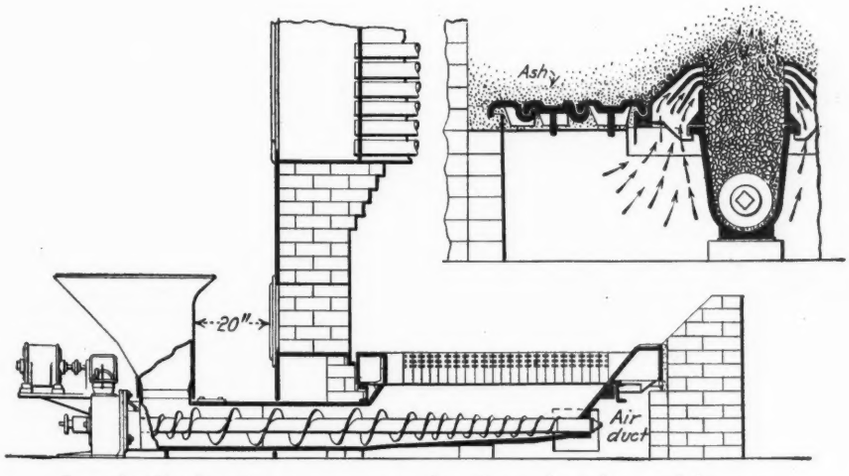
Stoker installation under return-tubular boiler

inches or more from the boiler front. The greatest over-all width, such as at the top of the hopper or across the drive unit, does not exceed 21 in. on any size of installation. The forced-draft fan is placed at the rear or at each side of the setting, to suit the arrangement of the boiler room.

An important feature of the stoker is the design of the screw conveyor, which contrary to usual practice, is turned continuously by a motor through a geared speed reducer, with speed variation to regulate the amount of coal fed to the fire. This screw conveyor is divided into three stages. Under the feed hopper the flights are of increasing diameter and of relatively small pitch, so that the screw will take the coal uniformly from the full area of the hopper throat. Delivery is made to the central, or conveyor, section of the screw, in which flights of uniformly large diameter but of longer pitch double the flight volume over that of the average feeder flight. In operation, the conveyor tube for the full length of the section is but half full of coal, thus preventing binding and clogging. This construction has proved to be a factor in reducing the power requirements of the stoker.

Air for combustion is introduced through tuyeres having 3½ sq.in. of air-cooled surface to 1 sq.in. exposed to the heat of the fire. To give ash-accumulating capacity and less frequent cleaning intervals, they rise above the deadplates. At the point of air introduction the retort is very narrow, so that, with the air feed from both sides, oxygen is supplied freely to the fuel bed.

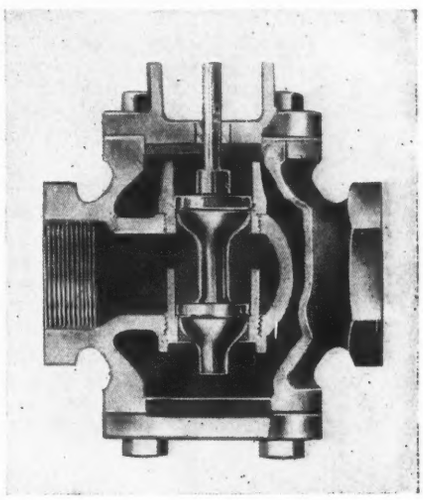
Control of both the stoker and fan motors in unison is effected by a pressure or thermostatic regulator functioning in conjunction with a combination starting box. By closing or opening the control circuit in accordance with the steam pressure or temperature the regulator causes the starting box to start or stop the two motors at the same time. Both the fan motor and the stoker-drive motor are so interlocked electrically as to make it impossible for the fan to continue running when coal is not being fed or to continue feeding coal when the fan is stopped. By means of a blast gate in the fan inlet the volume of air can be adjusted, so that the fuel bed may be built up before going on bank. In an emergency the boiler may be hand fired under forced draft. Overload and short-phasing protection are provided for each motor, so that if either unit is overloaded from any cause the main switch will open to stop both machines.



Longitudinal and transverse section through stoker and furnace.

Valve Designed for Graduated Flow Over Full Capacity Range

DESIGNED to give graduated port opening and graduated flow throughout its full capacity range, the Neilan "Parabolic" valve illustrated is adaptable for use in back-pressure or pressure-reducing regulators, in diaphragm or motor valves and in conjunction with other devices, such as temperature and flow controllers, where a balanced valve having a low



Cut-away view of valve

internal or operating friction is essential.

In the parabolic valve (so called because its flow curve is a parabola) the flow distributes evenly around the valve plug and there is no tendency for the valve to be forced against one side of the ports by the line pressure. The valve is guided through its full travel by guides having small surfaces, so that the friction is reduced to a minimum and little power is required to move the valve.

The parabolic valves, which are being put out by Neilan, Schumacher & Company, 641-651 Santa Fe Ave., Los Angeles, Calif., are normally furnished with cast-iron bodies, seats and valve plugs and stainless steel stems. They can also be furnished with stainless steel, monel metal or bronze seats and valve plugs. Also with aluminus or other alloy working parts. They are made in sizes from ½ to 10 in. and for pressures up to 400 lb. at 750 deg. temperature.

Time-Delay Device to Replace Relay

A NEW time-delay device, designed for use with manually operated switchboard oil circuit breakers types HA-2 and HC-2 put out by the General Electric Company is illustrated. The device, which consists of a coil, a calibrating tube and a piston dashpot, can be used in place of a relay where a time delay, not necessarily exact or selective, is desired. Current adjustment is made by setting the armature at the desired ampere value marked on the tube. Time delay is varied by changing the size of the opening in the piston valve. The device can also be obtained to replace instantaneous-trip mechanisms in breaker-operating levers of the types mentioned.

Time delay device ready for mounting

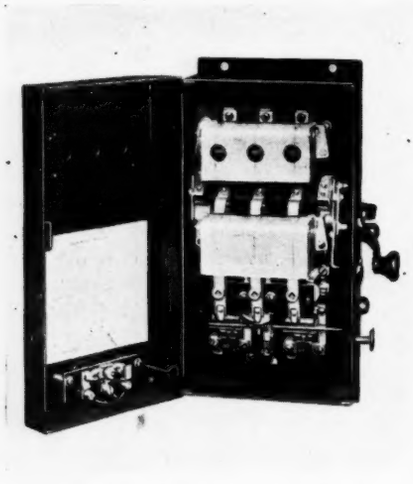
Starter With Test Jack

TO PROVIDE a means of obtaining load data on motors while they are running, the Square D Company, Detroit, Mich., has made provision in its new combination starter illustrated for the insertion of a test jack in the motor circuit while the motor is running.

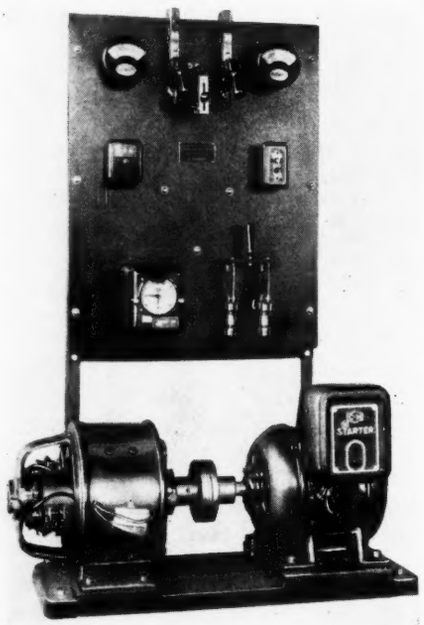
The combination starter is a complete unit consisting of an across-the-line starter and a motor-circuit switch mounted together in one cabinet. The motor-circuit switch not only acts as a disconnecting switch but also is capable of opening the circuit while the motor is under load. The starter may also be obtained with fuse blocks between the switch and the starter.

The test jack is inserted through openings in the door of the starter and passes between the jaws of the switch, where it is held by the spring tension of the switch contacts. The test jack may be ordered separately when desired, as only one is needed for an installation of several starters.

The combination starter is being put out in three ampere capacities and in six types, making use of across-the-line starters of the 30-hp., 220 volts, and 50-hp., 440 and 550 volts, two or three phase.



Starter with cover opened



Charger with control board mounted on base

Industrial Battery Charger

A NEW industrial battery charger complete with control board mounted on a common base has recently been added to the line of generating equipment put out by Engberg's Electric and Mechanical Works, St. Joseph Mich.

The charge consists of a motor generator with either direct or alternating current motor, to suit the conditions of the installation, and with switch-board to suit the type and number of batteries. They can be furnished for charging either one or more lead or Edison batteries either manually or automatically.

The motor-generator is a four-bearing unit, fitted with anti-friction bearings and a flexible coupling between the machines.

Small Acetylene Torch for Maintenance and Repair

A SMALL acetylene gas tank fitted with a torch close to it and with a handle so that it can be conveniently held with one hand is illustrated. The torch is particularly adaptable to all kinds of soldering, wiping and similar operations on wiring and switchboard connections, as a wide range of flames is obtainable.

The torch is conveniently held in one hand

The outfit, which is put out by the Linde Air Products Company, 30 East 42nd St., New York City, consists of a small tank containing 10 cu.ft. of acetylene, a short length of hose, a torch with various attachments and a lighter.

New Welding Electrode

A NEW electrode for the arc welding of mild steel and for repair work on cast iron is announced by the Lincoln Electric Company, Cleveland, Ohio.

The composition of the electrode, which is designated the "New Kathode," is such that it flows easily, with freedom from sputtering, and is claimed to produce clean welds, with minimum slag and oxidation, as well as leaving a weld on steel that is soft and readily machinable.

The electrode is manufactured in stock lengths of 14 and 24 in. and is packed in metal containers holding 50 pounds each.

The Relation of Theory to Practice in Plain Bearing Lubrication*

***While** the theory of bearing lubrication has the appearance of a complicated mathematical treatise, it has nevertheless brought out some decidedly practical points that should be understood by the engineer.*

IN THE past there has been a tendency to set up empirical bearing lubrication rules based upon particular sets of conditions, which resulted in considerable confusion. Some thought that, for perfect fluid film lubrication, the total friction varied as the square root of the total load. Others saw no relation at all between total friction and load. These latter pointed out that the coefficient of friction, consequently, had to vary inversely with the load. Still others thought that the total friction varied directly with speed, while others thought that it varied with the square root of speed.

The reason for this disagreement lay in the fact that the early investigators failed to recognize all the variables controlling the phenomenon of bearing lubrication, i.e., total frictional resistance, radius, length, clearance, eccentricity, load, speed, viscosity of lubricant, oiliness of lubricant, adhesive forces between oil and metal, amount of lubricant fed to the bearing, nature of the surfaces, materials of construction and temperature.

Not until Osborne Reynolds evolved his hydrodynamic theory of lubrication was a real advance made. Although based upon a number of assumptions which may or may not have been strictly true, Reynolds' mathematical reasoning demonstrated certain facts that were only felt to be so, and other facts which perhaps were never thought of before. He showed, for instance, that the pressures within an oil film could not be uniform, and further showed how they varied with the oil film. He also demonstrated the distribution of oil pressures over the journal surface, and predicted the exact location of the points of maximum and minimum pressures. He further showed that the wedge shape of the film was essential for the automatic generation of pressures within the film and the consequent load-carrying capacity of such wedge-shaped films.

His conclusions may be summarized as follows:

1. The load that can be carried is directly proportional to the viscosity of the oil.
2. The load is directly proportional to the journal speed.
3. The load that can be carried is inversely proportional to the square of the oil film thickness.
4. That strictly parallel plane surfaces could not carry any load at all.

While observers have noted that ordinary thrust blocks with parallel surfaces do carry light loads quite successfully, probably this is to be attributed to the fact that the surfaces are not absolutely parallel, in the sense of the theory, but rounding off at the edges of the oil grooves gives wedge-shaped oil films, at least in some parts of the bearing surfaces.

As a matter of fact, the design of modern thrust bearings has recognized the necessity for wedged-shaped films. Oil films are caused to assume that shape by having segments or shoes composing the stationary wearing surface so designed that under operating conditions they are very slightly inclined to the opposite, revolving, surface. The oil films between them are therefore wedged shaped, the thin end pointing in the direction of rotation of the plain bearing relative to the shoes: The principle of tiltable blocks has also been applied to the design of journal bearings.

Reynolds' conclusion as to the proportion between the viscosity of the lubricant and the load that successfully may be carried has become one of the guiding principles of bearing design. The fact that heating of the oil means an immediate drop in viscosity, thus lowering its load-carrying capacity, is making a suitable means for cooling the oil an essential part of every bearing design. One system of heat disposal provides for a continuous circulation of the oil. The heated oil is removed from the bearing housing, cooled and returned. Another system provides for cooling the oil within the bearing housing by means of water passing through a coil of pipe. Of course, where the heat carried off by the metal and given up to the air is as large as the heat generated, no additional means for oil-cooling is required.

Many other significant facts contained in Reynolds' studies did not become of practical significance until interpreted by later authorities. It was pointed out that a journal running in a full bearing undergoes a displacement in a direction at right angles to the line of load, and that the point of nearest approach between the journal and the bearing is on a diameter at right angles to the line of load. It was also found that the location of the point of maximum and minimum pressures was symmetrical with respect to the point of nearest approach and the manner in which the oil film varied over the journal surface.

As a result of these studies, the oil-feed line and oil grooves can now be logically located in the zone of lowest pressures, permitting ready introduction of the lubricant into the bearing. The graphical form of the theory, developed by Howarth, permits ready calculation of correct viscosity or clearance ratio for any definite operating condition. Of course, there are still discrepancies between theory and fact which so far have defied all rigid mathematical analysis. In spite of this, however, theory has developed definite facts which have become the guiding ideals in modern bearing construction and bearing lubrication.

*Abstracted from *Lubrication*, June, 1929.

Pipe Erosion in Steam Mains Negligible at High Velocities

THE erosion of pipe due to high-steam velocities is a negligible factor in the design and maintenance of steam mains, according to results of a survey made by the distribution committee of the National District Heating Association.

Although there is some doubt that the period of time elapsed since installation is of sufficient length to establish an unqualified conclusion, the results indicate "that no concern need be felt in the design of any steam main for velocities up to approximately 50,000 feet per minute." Pressure drop, and pressure drop alone, is taken as the criterion for design, and in one of the installations mentioned velocities as high as 75,000 per minute have existed with no apparent harm.

It has been customary on such installations, the survey indicates, to use steel pipe and extra-heavy cast-iron or preferably cast-steel fittings, but no erosive effects of any kind were reported with the exception of "some slight localized scoring at points where the direction of flow is reversed, such as in reducing valves."

Higher Steam Temperatures Favored in Europe

DECIDED tendency toward higher steam temperatures, rather than toward higher pressures, is noted in Europe by several observers in a report on foreign developments recently published by the prime movers committee of the National Electric Light Association.

At Witkowitz, Czechoslovakia, steam temperatures of 930 deg. F. are in use, and several Loeffler boilers operating at 900 deg. F. are now in use in England. Operation at temperatures above 800 degrees has been carried on for considerable time both in England and on the Continent, and, according to the report, superheating equipment, piping and turbines have stood up successfully under these temperatures. Most of the manufacturers are willing to build turbines for this service. They say that high steam temperatures are entirely a matter of superheater equipment.

FROM AMONG READERS' PROBLEMS

Conducted by L. H. MORRISON

MORE WIREDRAWING OF STEAM WITH EARLIER CUTOFF — *When earlier cutoff is obtained with a slide-valve engine by adding lap to the valve and advancing the eccentric, why is there more drop of the pressure during admission and more gradual cutoff, than with less advance of the eccentric?* C. M. W.

Assuming that the engine shaft rotates at a uniform speed, the valve is moved at the highest velocity when the eccentric is at right angles with the eccentric rod, or neglecting angularity of the eccentric rod, the quickest movement of the valve in opening or closing and greatest opening would be obtained with no lap and no angle of advance. By advancing the eccentric and adding lap, the valve opens after it has passed the point in its travel where it has greatest velocity and is slowing down more and more as it nears the end of its stroke, and complete cutoff occurs when the valve has attained only the same velocity in its return stroke as it had when admission occurred. Hence, the earlier the cutoff obtained by advancing the eccentric, the less the amount of opening and the slower the movement of the valve as it closes, thus giving rise to wiredrawing of the steam during admission and cutoff.

CAUSE OF GENERATORS' COMMUTATORS BLACKENING—*There are two 125-volt belt-driven direct-current generators in our plant operated in parallel and used as exciters. We have much trouble with the commutators blackening on these machines. The commutators become black in a few hours after they have been cleaned. All the usual methods of correcting the trouble, such as grinding the commutator with a handstone, fitting the brushes to the commutator, adjusting the brush tension, and checking the position of the brushes on the commutators, have been tried. When the brushes were changed different grades were used, but this did not improve conditions. What else might we try to correct the trouble?* B. M.

One of the first things to make sure of is that the machines are not overloaded. Unless the switchboard meters have been checked since the trouble started, they should be to ascertain that they are indicating the correct load on the machines.

When checking the position of the brushes, not only the neutral position should be determined but also the spacing of the brushes. Unequal spacing of the brushes may cause heavy circulating currents between the different groups of brushes. Under these conditions, the machines may be heavily overloaded when the meters show less than full load. Unequal air gaps between the field poles and the armature are another cause of circulating current.

Machines that have interpoles are sensitive to brush position and to the strength of the interpoles. Unless the interpole winding is adjusted to give the proper field strength, there is likely to be blackening of the commutator and sparking at the brushes. Even though the interpoles may have been properly adjusted when the machines were put into service, it is possible for them to get out of adjustment due to worn bearings making their air gaps unequal, poor connections between the interpole field coils, or a poor connection on the interpole shunt.

There are so many causes that can produce blackening of the commutator that it is difficult to give any definite answer to such a problem. The first thing to do is to put the machine into good condition mechanically. If this does not cure the trouble then it becomes a case of finding the electrical trouble by a series of tests and a process of elimination. The foregoing statements have been made on the assumption that the blackening of the commutator is something that has developed after the machines operated satisfactorily long enough to prove that fundamentally nothing is wrong in the design.

HEAT EQUIVALENT TO HORSEPOWER-HOUR—*How many heat units are equivalent to one horsepower acting for one hour?* A. F. M.

Carefully conducted experiments have shown that taking one British thermal unit as the mean heat required to increase the temperature of 1 lb. of water per deg. F., between 32 and 212 deg. F. gives

1 mean B.t.u. = 777.54 standard foot-pounds

This quantity is called the mechanical equivalent of one heat unit and, for practical computation, usually is taken as 778 foot-pounds. One horsepower = 33,000 ft.-lb. per minute, or acting for one hour 33,000 × 60 = 1,980,000 ft.-lb. Hence 1,980,000 ÷ 778 = 2,545 B.t.u. are equivalent to one horsepower acting for one hour.

PREVIOUS QUESTION

DISCUSSED BY READERS

THE QUESTION

IS OIL at $1.40 *a barrel a cheaper fuel than anthracite buckwheat at* $6.60? L. L. P.

IT IS necessary to find how many B.t.u. will be purchased for each dollar expended. Assuming 18,700 B.t.u. per pound of oil and 7.90 lb. of oil per gallon, a 42-gal. barrel of oil will contain 6,204,660 B.t.u. At $1.40 per barrel, 4,435,000 B.t.u. can be purchased for each dollar.

Assuming 12,500 B.t.u. per pound of buckwheat as delivered, each 2,000-lb. ton will contain 25,000,000 B.t.u. At $6.60 per ton, 3,788,000 B.t.u. can be purchased for $1.

The question arises as to how the fuel is to be used. In burning buckwheat, a boiler efficiency of 75 per cent may be expected in modern stoker-fired plants. Boiler efficiencies when burning oil average 80 per cent.

The amount of equipment as well as its cost for each installation, ease of storing and handling, and ease of operation must be considered. In most cases, the balance will swing in favor of the fuel oil. However, it must not be forgotten that boilers and furnaces must be specially built for oil-burning, or high upkeep will result.

There are so many factors to be considered that each case is a problem of its own. Hence, no definite answer can be given without more specific information on this particular case. On the surface, however, it would appear that fuel oil will be cheaper than the anthracite buckwheat.

WESTON A. BROWN,
Ohio Power Company.
Philo, Ohio.

IN ORDER to find the number of barrels of oil equivalent to a ton of coal, it would be necessary to know the heat content of the oil and the coal, the weight of a gallon of oil, the boiler efficiency obtained while burning coal and oil, whether the coal is sold on a short- or long-ton basis and whether the prices mentioned include the handling and storage charges.

Since these facts are not at hand, let

us assume that the coal is sold on a short-ton basis and that the cost of both oil and coal includes handling and storage charges. Being anthracite buckwheat it would, on average, probably contain about 14,000 B.t.u. per lb. Therefore: 14,000 (B.t.u. per lb.) × 2,000 (lb. per ton) = 28,000,000 B.t.u. per short ton.

In the case of the oil, let us assume the oil weighs 8 lb. per gallon and contains 18,000 B.t.u. per lb. Therefore 42 (gal. per barrel) × 8 (lb. per gal.) × 18,000 (B.t.u. per lb.) = 6,048,000 B.t.u. per barrel of oil.

Under normal conditions, a higher efficiency should be obtained when burning oil than when burning coal. Let us assume an average of 72 per cent efficiency when burning coal and 77 per cent with oil.

If we have 28,000,000 B.t.u. in a ton of coal and 6,048,000 B.t.u. in a barrel of oil, when these are burned at an efficiency of 72 and 77 per cent, respectively, we should utilize 28,000,000 × .72 = 20,160,000 B.t.u. with coal and 6,048,000 × .77 = 4,656,960 B.t.u. with oil. Therefore, $\frac{20,160,000}{4,656,960} = 4.329$ barrels of oil is equivalent to a short ton of coal under the conditions assumed above.

From this we have: 4.329 × $1.40 = $6.06, which is the cost per ton at which coal would have to be purchased to be equivalent to a barrel of oil at $1.40.

There are many factors that enter into a comparison of the costs of coal- and oil-burning other than the comparative cost per B.t.u. of coal and oil as figured above.

WILLIAM H. SCOTT,
Merrimac Chemical Company.
North Woburn, Mass.

IN GIVING an answer to this question not only cost per B.t.u. but also cost per pound of steam delivered from the boiler, as well as ease of handling, must be considered.

Assuming 42 gal. to a barrel of oil of specific gravity of 0.86 and of a heating value of 19,000 B.t.u. per pound, and a long ton of anthracite buckwheat with a heating value of 12,000 B.t.u., the barrel of oil will contain approximately 5,700,000 B.t.u., making the cost per million B.t.u. 24c. The ton of coal will contain 27,000,000 B.t.u., making the cost per million B.t.u. also 24c. The figures assumed for the heating values of the two fuels may vary slightly from those chosen but not enough to disprove that, as far as heat value is concerned, oil at $1.40 a barrel *is* as cheap as anthracite buckwheat at $6.60.

A boiler and furnace using buckwheat anthracite will have for their maximum efficiency a value of about 65 per cent. A steam-generating unit of the same size using fuel oil will have an efficiency of about 75 per cent. Using these figures we find, assuming 1 lb. of steam contains 1,000 B.t.u., that 1,000 lb. of steam costs 37c. if we use coal, and only 32c. if we use oil.

GORDON R. HAHN,
New York Edison Company.
Westfield, N. J.

IF WE assume a heat value per pound of coal as received for the anthracite as 13,500 B.t.u., we have

$$\frac{13,500 \times 2,240}{6.60} = 4,581,818 \text{ B.t.u. per dollar.}$$

For the oil, if we assume an oil of 16 deg. Baumé and 6,302,000 B.t.u. per barrel, we have

6,302,000 ÷ 1.40 = 4,501,428 B.t.u. per dollar.

Based on these assumptions, the coal is slightly the cheaper fuel on a basis of comparative heat values alone, to the extent of 1.78 per cent.

To determine which will actually be the cheaper fuel for the particular plant under consideration, it will be necessary to compare the cost of handling the two kinds of fuel, the cost of ash disposal, and any other factors that will be influenced by the type of fuel selected.

HOWARD LIVINGSTON.
Los Angeles, Calif.

A Question For Our Readers

I graduated from an engineering school in June. I think I would like power engineering but find that to start I must first go into a boiler room. Is there enough future in power engineering to justify this step? R. C. DE S.

Suitable answers (of 200 words or less) from readers will be paid for and published in the Sept. 10 issue.

THE initial cost of equipment for oil-firing would be far less than that of the stoker equipment necessary if 75 per cent efficiency is to be realized on buckwheat coal. The maintenance expense on burners will also be considerably less than on a stoker.

When it comes to labor, fuel oil holds a decided advantage, inasmuch as one man can properly care for a battery of oil-fired boilers totaling several thousand square feet of heating surface. The expense of coal passers is entirely eliminated, as is the cost of ash removal.

In plants where the fires are banked overnight or for long periods and in cases of sudden and variable steam loads, fuel oil will show savings.

The cost of handling coal from the cars to bunkers will be higher than in the case of fuel oil, and the amount of space necessary to charge against the boiler plant for coal storage will exceed that necessary for fuel oil of equal heat content.

K. E. DE ROSAY,
Atlantic Refining Company.
Philadelphia, Pa.

OIL at $1.40 per barrel is cheaper than anthracite buckwheat at $6.60. As 1 lb. of oil contains 18,500 B.t.u., a barrel of 42 gal., or 336 lb., will contain 6,216,000 B.t.u. At $1.40 per barrel 1,000,000 B.t.u. cost $0.225.

Average anthracite buckwheat contains 13,180 B.t.u., and a ton of 2,000 lb. contains 26,360,000 B.t.u. At $6.60 per ton, 1,000,000 B.t.u. cost $0.25. The boiler and furnace efficiency with oil is 78 per cent, and with coal it is only 65 per cent. Therefore, the cost of 1,000,000 heat units of coal converted into steam would be $0.326, and of oil would be $0.288.

Stokers, ash-handling and auxiliary equipment for burning coal averages $2.00 per square foot of boiler heating surface, and for oil-burning the storage tanks, pumps, heaters and burners will cost $2.50 per square foot.

Advantages of oil are: Better boiler efficiency, less excess air, no ash pit losses, constant furnace temperatures, clean heating surfaces, cheapness of handling, no storage deterioration and no dust around the plant.

Advantages of anthracite are smokelessness, no danger of fire and the impossibility of suddenly losing steam pressure, such as the break in an oil line would cause. Smokeless oil-burning can be accomplished by suitable operating conditions. L. G. BIRD.
Chicago, Ill.

THE cost is the same, as both the oil and the coal cost approximately 22 cents per million B.t.u. available. However, if the intent of the question is to determine whether to use oil or fuel, consideration must be given to the type of installation to be used. If automatic stokers are to be installed, the efficiency of the boiler plant will be about the same as with oil, whereas with hand-firing it will be about 16 per cent less than with oil.

This is not the whole story, since numerous other factors enter the problem affecting the saving possible to a much greater extent than the relative calorific values of oil and coal. Some of the factors which should be considered in comparing the use of either coal or oil are the labor-saving possible, load factor, quantity of coal required for banking, space available for fuel storage, and, above all, the availability of oil over a period of years at a standard price.

JOHN B. GORUM.
Schenectady, N. Y.

THE heating value of a ton of No. 1 buckwheat coal is 11,900 × 2,000 = 23,800,000 B.t.u. The heating value of a barrel of oil of 42 gal. is 315 × 18,000 = 5,676,000 B.t.u. On the basis of B.t.u. per dollar, oil is the cheapest fuel, and the increased boiler efficiency with its use due to less excess air required for its combustion will be an added point in its favor. EDGAR P. WANNER.
Lancaster, Pa.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

*Spot * News*

A HIGH PRESSURE LOCOMOTIVE *recently manufactured by Reichsbahn-Zentralamt of Berlin, Germany, will shortly leave the shop for its first boiler tests. It is equipped with a Loeffler boiler, pulverized-coal-fired, to supply steam at a pressure of 1,700 pounds.*

* * *

FINAL PERMISSION *has been granted the Union Electric Light & Power Company of St. Louis, by the Missouri Public Service Commission to proceed with its $30,000,000 hydroelectric power project on the Osage River near Bagnell, Mo.*

* * *

A NEW HIGH LEVEL *was reached in the daily average production of crude oil during June, according to figures just released by the Department of Commerce. Production amounted to 83,403,000 barrels for the month, an average of 2,780,000 barrels a day.*

* * *

GOVERNOR ROOSEVELT *has just ordered another study of the electric power merger under the name of the Niagara-Hudson Power Company, and has appointed his personal counsel to advise him whether the formation of the company is a violation of the New York State law.*

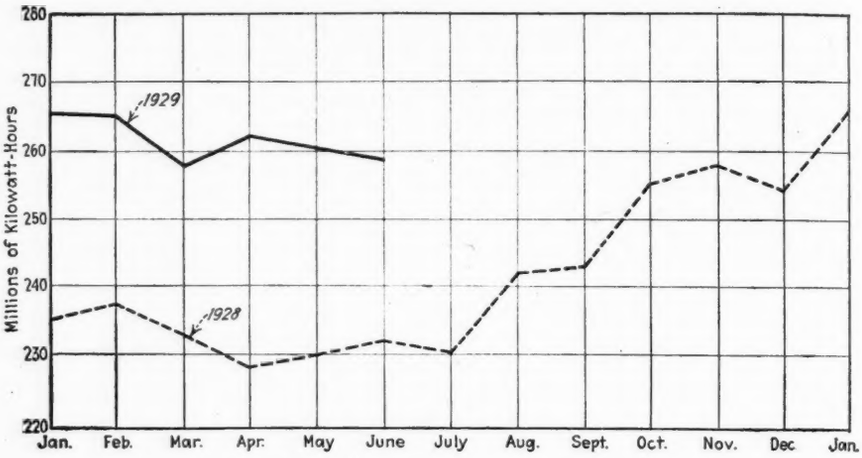
* * *

FRANCE, *Austria, Japan and Argentina have already drawn up preliminary plans for the observance of Light's Golden Jubilee in the fall. Italy, Germany, Holland, Sweden, China, Mexico and Brazil are working on plans but have not as yet announced the details.*

* * *

CONSIDERATION *of whether the detailed inquiry in regard to the numbers and horsepower of the several classes of prime movers used in industrial establishments shall be carried on the schedules at every biennial census of manufactures or at alternate censuses, is being given by the recently appointed Census Advisory Committee.*

Utility Power Production Maintains Increase Over 1928



Daily average production of electric power by public utility power plants in the United States

DESPITE the marked decrease in the production of electricity by the use of water power during June, a total average, from all sources, of 259,000,000 kw.-hr. a day was produced during that month, a decrease of less than 1 per cent from the daily rate for May. Low precipitation during the month of June in the eastern part of the United States was the cause of the decreased production of electricity by water power. The increased used of steam, however, made up for this discrepancy and kept the daily rate well above that for June, 1928.

The total production of electricity for the first half of 1929 was 47,392,000,000 kw.-hr., an increase of 12 per cent over the production for the corresponding period in 1928. Based on the output for 1928, the total output for 1929 will be about 98,000,000,000 kw.-hr. These figures were compiled by A. H. Horton of the Division of Power Resources, Geological Survey of the United States Department of the Interior.

Preliminary Boulder Dam Plans Now Being Formulated

Views of representatives for the various states, municipalities and power companies interested in securing contracts for power to be developed by the Boulder Dam project have been submitted to Secretary of the Interior Wilbur. Efforts are being made to formulate a program that will be most satisfactory from the standpoint of all interested parties. The fact that contracts for power to be developed at Boulder Dam must be let before actual construction work is begun makes controversy objectionable.

While no appropriations have been made for actual construction of the dam, and none are expected until the next regular session of Congress, the Denver office of the Bureau of Reclamation has been authorized to increase its engineering staff. This enlargement in personnel is due to the additional work that has fallen upon that office in the preparation of the designs incidental to the construction of the dam.

Aside from the plans for the great dam itself are those of two cofferdams, one of which is above the site of the dam and the other below it. The cofferdam upstream, 80 ft. high, will be capable of diverting the Colorado River even in flood time.

The cofferdams will not need to be completed, however, until the four great diversion tunnels that must be put through the solid rock of the canyon side have been drilled. Each of these tunnels will be 50 feet in diameter. Two of them will be permanent spillways and two will supply water to the power houses, which are intended to generate enough electricity to pay for the entire project. The work on the designs of all these structures is already under way in the Denver reclamation office, and it is expected that all will be completed in advance of the time when money is

available for actual construction.

The Department of the Interior has drawn up plans for a town in which will live the workmen who construct the dam. The site for the town, which was selected by Secretary Wilbur and Elwood Mead, Commissioner of Reclamation, is on the Nevada side of the river a little more than a mile from the site of the dam. Experts are working on details intended to make it a model community.

The task of lowering a thousand or more men 1,600 feet from the canyon rim and the town to the bottom of the valley, where work must begin, is also a problem in engineering design. It will be accomplished through the installation of huge elevators that will lift their passengers a perpendicular distance of 1,000 feet, practically twice as great a lift as that to the top of the tallest skyscrapers.

The possibility that the construction town may become a popular resort after the construction of the dam, due to the scenic and engineering interest of the project, and the fact that the dam when completed will form a bridge across the canyon, has led the designers to plan the town as a permanent community. By retaining ownership of the land and making leases contingent upon good behavior of the tenant, the government hopes to avoid many of the objectionable characteristics of the usual construction town.

Pulverized Coal Installations Increasing in Germany

Germany's pulverized-coal-firing installations are increasing in number, according to a report of the Department of Commerce, made public recently. On April 1, 1928, there were in Germany 914 pulverized-coal-firing installations, compared with 763 on the corresponding date of the preceding year. These 914 installations were divided among 272 plants, and included 545 industrial furnaces and 369 steam boilers. Of the steam boilers, 300 were located in Prussia.

During 1928 these installations consumed 4,800,000 tons of pulverized fuel, compared with 3,700,000 tons consumed in 1927. Of the 1928 total, 930,000 tons represented lignite and 3,870,000 tons bituminous and anthracite coal.

The firing of industrial furnaces took 220,000 tons of pulverized lignite and 1,970,000 tons of other pulverized coal, while steam boilers required 710,000 tons of lignite and 1,900,000 tons of bituminous and anthracite coals.

In April, 1928, there were 23 industrial furnaces and 75 steam boilers for pulverized fuel firing under construction. The fuel consumption of these installations has been estimated at 162,600 tons of lignite and 669,000 tons of other coals annually. The proportion of lignite used in pulverized fuel firing is therefore only about one-quarter of that of other coals, and it is said to appear unlikely from present indications that this ratio will be changed in the near future.

Need for Steam Plants in Ontario Postponed by St. Lawrence Project

Power Commission Continues to Meet Growing Requirements of Province

An Interview Given by Frederick A. Gaby to Campbell Bradshaw

ANNOUNCEMENT by Governor Roosevelt July 24 that plans for a hydro-electrical development, of a capacity of 2,400,000 hp. a year, at International Rapids, on the St. Lawrence River, to be shared equally by New York state and Canada, will be submitted to the next session of the New York Legislature, confirms the view of members of Ontario's Hydro-Electric Power Commission that the day is still far distant when it will be necessary—at least from a power supply standpoint—to erect steam plants to augment the hydro-electrical energy available in Ontario.

While the Ontario Commission—which today consists of Charles A. Magrath, chairman; J. R. Cooke and C. Alfred Maguire, commissioners; W. W. Pope, secretary; and Frederick A. Gaby, D.Sc., chief engineer—does not hesitate to purchase power when it feels such a purchase is in the best interests of the municipalities concerned, the bulk of the energy supplied by the commission still comes from the 22 publicly owned hydro-electric developments in operation, Mr. Gaby last week informed *Power*, pointing out that the energy purchased, in peak horsepower, according to the last report of the commission, totaled but 153,957 of a distribution of 1,032,500 hp. in all.

The three main sources of supply that remain to meet the ever-increasing demands of industry, Mr. Gaby declared, are:

1. The international portion of the St. Lawrence River, from Lake Ontario to St. Regis, below Cornwall, which has a fall of a little more than 90 ft., of which between 80 and 85 ft. can be developed by building a series of dams and dikes, while fully safeguarding all navigation requirements, about 2,000,000 hp. being the aggregate installed capacity. The development of this part of the river for power does not present the economic problems which have to be considered in making it navigable from the Great Lakes to the sea, it being a relatively simple matter to make provision for such locks and other structures as may be required.

2. The Ottawa River, an interprovincial stream, with several large power sites, the total power available depending upon the storage provided and the extent to which the flow is regulated. Probably this river can be made to yield 1,000,000 hp., half of which would belong to Ontario.

3. The Niagara River. The water available here under the terms of the boundary waters treaty of 1909 is practically all in use now, and no further power development can be carried on by either side without an enlargement of present treaty allotments. Here, however, every cubic foot of water, under the full head, produces 30 hp. An additional 10,000 cu.ft. of water would, therefore, produce 300,000 horsepower.

With three such sources of supply far from exhausted, the Ontario commission has by no means reached the stage of having either to purchase power or generate it from coal to meet the further demands of the province. In fact, as long ago as 1908 it was deemed in the interest of municipalities to buy power, and since then contracts have been made with a number of companies for the supply or interchange of power.

Power for the Ottawa and St. Lawrence systems is purchased, as also is some of the power used on the Niagara system, on the central Ontario and Trent system, and on the Rideau system. On the Georgian Bay system surplus power is exchanged with, or purchased from, the Orillia Water, Light & Power Commission.

Pending the removal of certain difficulties in the construction of new developments on the international portion of the St. Lawrence and on the Ottawa River, a supply of power has been arranged for from the Gatineau Power Company, the contract providing for the ultimate delivery of 260,000 hp. of 25-cycle power, and up to 100,000 hp. of 60-cycle power. The 25-cycle power is received at the interprovincial boundary on the Ottawa River and conveyed over a new 220,000-volt transmission line to Toronto. This purchase releases an increased amount of Niagara power for use in the more westerly portions of the Niagara system. The 60-cycle power, conveyed over 110,000-volt lines, takes care of the increasing requirements of Eastern Ontario.

The achievements of the Hydro-Electric Power Commission of Ontario since it began to actually supply electrical energy show the extent to which its development has made many of the industries of the province independent of outside sources of fuel supply for power purposes. Entering into a contract with the Ontario Power Company for the purchase of electrical energy up to a maximum of 100,000 hp. the commission proceeded to build transformer stations and transmission lines for the distribution of power to twelve municipalities in 1910, its initial capital expenditure for this purpose being around $3,600,000.

The small initial load of less than 1,000 hp. increased rapidly, and in 1915 130 municipalities were being served, the limit of its contract with the Ontario Power Company having been reached. Arrangements were then made for additional supplies, 50,000 hp. being obtained

from the Canadian Niagara Power Company and 25,000 hp. from the Toronto Power Company.

In August, 1917, the commission purchased outright the Ontario Power Company, with plant capacity of 160,000 hp.—increased to 180,000 hp. in 1919. In 1920 the 125,000-hp. plant of the Toronto Power Company was acquired, the load, serving 263 municipalities, then being 356,000 hp. In view of such a rapid increase in demand, legislation was next enacted authorizing the construction of the Queenston-Chippawa development, the first unit being placed in service in 1922. In 1925 the number of cities, towns and townships served had grown to 436. As a result a ninth unit was installed at Queenston and the plant brought to its present capacity of 550,000 horsepower.

Today, including the power exported under long term agreements entered into by certain companies before their acquisition by the commission, 1,032,500 hp. is being distributed, and 25 cities, 84 towns and 225 townships served. With new plants in course of construction and additional power to be supplied under contract, the commission is ready today to supply around 1,400,000 horsepower.

No review of the achievements of the Hydro-Electric Power Commission of Ontario would be complete without mention of Sir Adam Beck—for nearly twenty years head of the commission of whom it may be truly said that he made the undertaking his life's work—its outstanding success in large measure being the result of his constructive ability, zeal and administrative capacity.

Diesel Compressed Air Drives Rejected as Too Costly

All bids for the construction of Diesel-compressed air driven tow boats for service on the upper Mississippi were rejected at the meeting of the board of the Inland Waterways Corporation on Aug. 1, and it was decided to invite new bids based on a modified design. The new bids, which will apply to a steam-driven vessel of slightly wider dimensions than were called for in the former bids, will be opened on Aug. 20. It is understood that excessive cost is the reason why the bids for the Diesel-compressed air boats were thrown out.

Consideration is being given also to the advisability of buying new and more powerful tow boats for the New Orleans-St. Louis service. The Dravo Construction Company of Pittsburgh is reported to be working on plans for a new type of vessel, which, it is claimed, will bring about great operating economies. Engineering officials of the government barge line are now in Pittsburgh inspecting these plans.

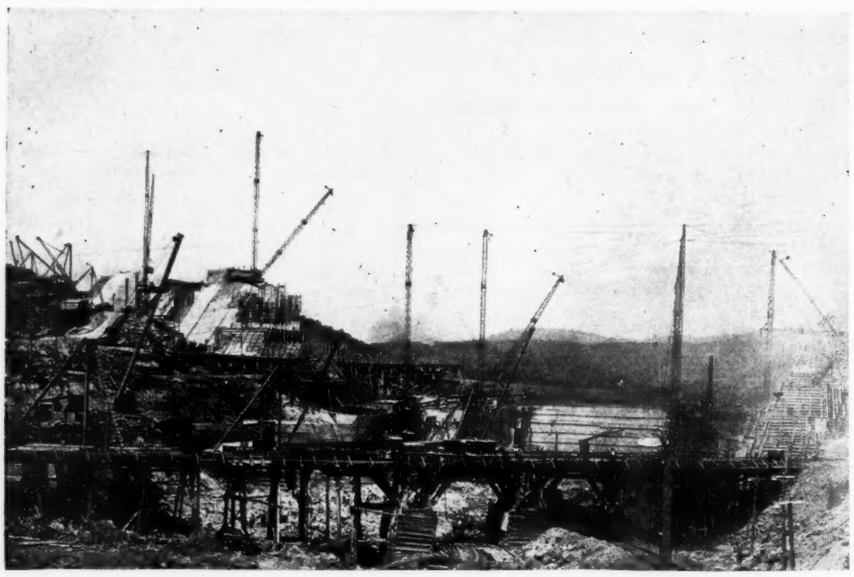
Coal Operators Clamor For Tariff on Oil

The bituminous coal industry has come to the support of the independent petroleum producers in their plea for tariff protection. The proposed duty, $1 per barrel on crude oil and 50 per cent ad valorem on petroleum products, would protect the bituminous operators from a loss of market caused by an influx of cheap foreign oil, according to Harry L. Gandy, executive secretary of the National Coal Association. Admitting that the proposed tariff would raise the price of fuel oil along the Atlantic seaboard, Mr. Gandy contended that it would not raise the prices above the normal level, but would restore prices to the level prevailing before the influx of Venezuelan petroleum—which would bear a normal relation to prices in other parts of the country. The competition between bituminous and domestic fuel oil would be little changed by a duty that kept out foreign oil, he contended.

Huge Pipe Lines For British Power System

A contract has just been placed in Durham, England, for the supply and erection of two high-pressure pipe lines for the Grampians hydro-electric supply system in Scotland, the water for which is to be drawn from Loch Ericht at an altitude of 1,150 ft. and brought through a tunnel about 3½ miles long to a power station on the shores of Loch Rannoch at an altitude of 676 ft. This tunnel, which is 12 ft. 6 in. in diameter, will bifurcate at its lower end into two 11 ft. 6 in. steel pipes which, when lined with concrete, will have a finished diameter of 10 ft. 6 in. At the portal, which is 1,030 ft. above sea level, these pipes will each bifurcate into two 94½ in. steel pipes, so that there will be four outlets from the tunnel, two of which are to be closed for future development. From the valve house at the portal two lines of high-pressure pipes will lead from the hill to the power house, where the total static head will be about 500 ft. Two water turbines, with a total of 42,000 hp. will be erected, and the station when completed will be interconnected with existing steam stations in the Grampians area to supply the increasing power demand.

The high-pressure pipe lines, it is claimed, will constitute the largest water gas-welded steel pipes ever manufactured. The thickness of the pipes will range from ½ in. at the top of the line to 15/16 in. at the lower end, and the average length of each pipe will be 24 ft. 6 in. and the maximum weight of the heaviest pipe about 13½ tons. The pipe line is not straight, but proceeds in a series of steps, and at each bend it will be built into large reinforced concrete anchorages. The bends will have thrust rings to take the thrust of each section at the anchorages, on the downstream sides of which provision will be made to meet expansion and contraction. The circumferential joints



Lower Fifteen Mile Falls development

CONSTRUCTION is progressing rapidly on the 185,000-hp. lower Fifteen Mile Falls hydro-electric development of the New England Power Association, controlled by International Hydro-Electric System, a division of International Paper and Power Company. The development is on the Connecticut River in northern Vermont and New Hampshire, and is the largest hydro-electric development in the New England States. It is expected that the plant will be in operation by October 1 of next year.

This lower development is the first of two adjacent water-power sites to be developed by New England Power Association to meet the rapidly increasing demands for electricity in its territory. The two developments, eight miles apart, will have a combined capacity of about 300,000 hp. The dam at the upper development will also create a large reservoir for the regulation of the Connecticut River, benefiting not only the Fifteen Mile Falls plants, but also the plants of the Association now in operation at Bellows Falls and Vernon.

are of the lap type and are prepared for double riveting on the site. Before being put into commission each line will be tested to a pressure of 210 lb. per sq.in. applied at the top near the portal. Owing to the head this will will give a gradually increasing pressure, so that at the bottom of the line the test pressure will be 364 lb. per sq.in.

To enable it to make pipes of such large size the South Durham Steel & Iron Company has carried out substantial alterations to its plant, and during the last three years its pipe works at Stockton-on-Tees have produced steel pipes for two of the largest hydro-electric stations in Britain. One of these, for the Lochaber scheme in Scotland, now being completed, has two steel pipe lines with a bore of from 63 to 70 in., and a thickness up to $1\frac{1}{8}$ in.; while at Maentwrog, the North Wales power scheme has one steel pipe line 6 ft. in diameter with a thickness up to $1\frac{1}{4}$ in. In both these cases the pipes are 30 ft. in length.

Power or Scenic Beauty? Courts to Decide

Two conflicts between hydro-electric power interests and those who wish to preserve scenic beauty are still in the mazes of extended litigation. In the long controversy that has occurred between the Virginia Public Service Company and the Garden Clubs of Virginia over the project to develop the water power of the historic Goshen Pass the Virginia State Corporation Commission last week ruled that it had no jurisdiction in the case. In the commission's ruling that the beds of the streams were, by virtue of old land grants, private property rather than state property, there would seem to be a distinct advantage for the public service company. In fact, counsel for the advocate of the project has announced that the next step will be the acquisition of the remaining property needed for the development. The Garden Clubs and other organizations fighting the dam have not, however, given up the fight. They are expected to take the matter to the Virginia Supreme Court of Appeals.

Another conflict fully as bitter as the Virginia question has centered around the Cumberland Falls power project in Kentucky. Opponents of the proposed hydro-electric development, who contend it will mar the scenic beauty of the area, have filed a brief with the Federal Power Commission in answer to an opinion given by counsel to the executive secretary of the commission that such matters as scenic beauty could not legally be considered by the commission in acting upon power-project applications. This opinion has not yet, however, been voted upon by the commission. The body has jurisdiction over the project in so far as it would affect navigation in the Cumberland River below the falls, it has been decided. Attorneys representing the officials of ten Kentucky counties have filed a brief urging that a license be issued in the public interest. In their argument for the plant's construction they emphasize the fact that the 35-mile lake which would be created by the dam would provide a place for recreation purposes, and be of great benefit to the people of the state.

Men in the News

EDWARD P. DILLON

has been appointed vice-president and associate engineer of the E. Y. Sayer Engineering Corporation of New York City. Mr. Dillon has had a comprehensive experience in the field of power engineering. Graduating from the University of Colorado in 1899, he spent ten years in power plant design, construction and management. Then he sold power equipment for the Westinghouse Electric & Manufacturing Company. In 1918 he became general manager of the Research Corporation of New York, which position he leaves to enter this latest association in the design and construction of power and industrial plants.

Brooklyn Poly Gives Oil Engine Course

To meet the needs of those who wish to train themselves for operating, selling, building or designing Diesel and other oil engines, an evening course dealing with these engines will be given by the department of mechanical engineering of Brooklyn Polytechnic Institute beginning in September. Twenty lectures will be given, and these will be supplemented by laboratory and classroom work. Special emphasis will be laid on operation and maintenance. Certificates will be awarded to those attaining satisfactory ratings in the classroom work. There are no entrance requirements for the course.

National Fuels Meeting at Philadelphia Oct. 7 to 10

The third national fuels meeting, which will be held in Philadelphia, Pa., Oct. 7-10, 1929, will follow the same lines as the first and second national fuels meetings, which took the form of a fuels forum. A special effort is being made this year to include recommendations of societies other than the American Society of Mechanical Engineers as to the most effective manner in which the interests of fuels men in general may be served.

The following subjects will be treated in Philadelphia: economics of reclamation of anthracite culm, burning refuse fuels, low-temperature carbonization, the atomic basis of combustion theory, economics of gas, coal, and oil fuels, economics of oil production, heat value of fuel, coal pre-treatment, slag accumulations on boiler tubes, air needed for combustion of different fuels, design of furnace for tunnel kilns, development of refractories to meet needs of users, producer gas in brick kilns, fuel burning in ceramic and lime industries, application of fuels in the cement industry, burning pulverized anthracite, recent developments in stoker design (four papers), burning coarse coal in suspension, proper methods of pulverized fuel sampling, low-temperature coke for marine service, pulverized fuels in marine practice, methods of recording smoke (three papers), the effect of pulverized-fuel ash on the penetration of ultraviolet rays. At least an entire day will be devoted to smoke abatement with four papers on the general situation.

Construction at Mobile Plant Ahead of Schedule

With the erection of boilers and the installation of boiler room equipment virtually completed, it appears probable that the Mobile steam plant of the Southeastern Production Company will be supplying power and process steam to the International Paper Company one month ahead of schedule. The time schedule calls for completion of the plant by October 15, after a period of less than fourteen months in which the plant had to be designed and built. When the contract for power was signed about a year ago, the site for the plant had not even been chosen.

Immediately several special problems were met. The site, of course, had to be as near the paper mill as possible, to reduce the length of steam lines. Most of the surrounding property is a swamp less than two feet above normal tide water elevation. To build the plant on the mud bottom made it necessary to drive 526 piles 30 feet into the earth. These piles were cut off below water level and capped with two feet of concrete. The basement floor, forming a complete mat over all piles, is also two feet thick. The plant is located so that it will be possible to supply coal either

by rail or barge, although the rail connections only are being made at the present time.

The paper mill has a capacity of 170 tons of paper per day and will require 7,500 kw. to operate. Steam, for use in process work and in turbine-driven auxiliaries, is required at two pressures. A maximum of 85,000 lb. per hour will be used at 150 lb. pressure and 100 deg. superheat, and a maximum of 87,000 lb. per hour will be used at 35 lb. pressure and no superheat.

To serve this load a 6,000-kw. noncondensing bleeder type turbine was purchased from the General Electric Company and a 2,000-kw. condensing non-bleeding turbine was moved from Athens, Ga., thus giving the plant a total capacity of 8,000-kw. when operating at full load. The small 2,000-kw. unit is provided with a jet condenser and will be operated only in extreme emergencies. For normal operation process steam and electrical energy will be supplied from the 6,000-kw. bleeder type unit. Any excess power above this required by the paper mill will be supplied by the Mobile primary substation of the Alabama Power Company.

It is interesting to note that process steam can be furnished to the paper mill in quantities, pressures and temperatures desired even though the turbine is not in operation. Steam from the boilers at 450-lb. pressure and with 200 deg. F. superheat is bypassed through a desuperheater and reducing valve and is delivered to the line to the paper mill at 150-lb. pressure with 100 deg. F. superheat. Steam is taken out of this bypass, is sent through another reducing valve and desuperheater and delivered to the other line to the paper mill at 35-lb. pressure with no superheat.

Three boilers with a normal rating of 60,000 lb. steam per hour and a maximum rating per hour at 475-lb. pressure with 200 deg. F. superheat have been erected. Coal is burned on an underfeed stoker of a new design, it being the second installation of its kind in this country.

The forced draft fans have a capacity of 44,000 cu.ft. per min. and the induced-draft fans a capacity of 75,000 cu.ft. per min. Air for combustion is preheated to a maximum temperature of 325 deg. F. before it is delivered to the stoker wind box, where a constant pressure equal to seven inches (water) is maintained under the fuel bed.

Ashes are sluiced out of the hoppers under the boilers, through a trench into the plant sump. From the sump they are pumped and discharged into the swamp where they help to form a permanent fill around the plant.

Another interesting problem encountered was in the design of the pipe lines from the plant to the paper mill, a distance of approximately 550 ft. These lines are supported on steel towers spaced approximately 50 ft. apart, with steel trusses in between. Expansion is taken care of by three large expansion loops, 12 ft. in diameter, which is to care for the maximum of 8 in. of expansion that might occur in these lines.

Export Figures On Power Equipment

Forty steam turbine-generator sets valued at $108,551 were exported from the United States during the month of May, according to a Department of Commerce report. Three sets whose value totals $82,196, shipped to Mexico, comprise the major portion of the exports. This total is over five times the value of turbine-generators exported in April, when the value of such exports was $20,074.

Exports of turbines with mechanical drive totaled eleven for May, their value being $78,750, while of other types of steam engines, seventeen, with a total value of $16,023, were exported, fifteen of these engines went to Canada. While the number of units was a considerable decrease from the April total, value of the two classes showed an increase.

Diesel and semi-Diesel engines totaling 36, valued at $104,665, were shipped out of the country in May, a considerable decrease from the April figure of 85 units, valued at $189,167. In the marine field 126, to the value of $254,801, were exported in May as compared with 236 with a value of $177,044 in April. During both months the bulk of these engines went to Canada, with Spain and the Netherlands coming next.

Pumps fared well in May, with totals of 582 centrifugal, at $132,315; 87 rotary, at $4,670; 803 steam reciprocating at $171,987; and 1,617 other reciprocating, at $194,743. In April 419 centrifugal, at $97,925; 448 rotary, at $42,010; 745 steam reciprocating, at $222,995; and 1,532 other reciprocating, at $185,576, were exported.

OBITUARY

JOHN J. O'CONNELL, lieutenant colonel in the United States Army Ordnance Reserve, died in Rio de Janeiro, Brazil, on July 4. Colonel O'Connell was born in Emporia, Kan., Sept. 11, 1882. He was educated in the public schools of California, receiving an engineering degree from the University of California in 1908. He joined the staff of the Electric Bond & Share Company in 1912, and except for the war period served continuously with that company until the time of his death. His work included the investigation of hydro-electric power problems in the public utility field in the United States and abroad. During recent months he served temporarily as chief hydraulic engineer for the Emprezas Electricas Brasileiras. As soon as the United States entered the World War, he was commissioned as captain, Ordnance, United States Army, and for his brilliant work in connection with munitions production was promoted to the grade of major in August, 1918. Six years later he was promoted to the grade of lieutenant colonel.

PERSONALS

CHARLES E. STUART, who returned recently from a four months' trip in England, France, Germany and Russia, has associated his firm of Stuart, James & Cooke, Inc., consulting engineers, of New York City, with Bewick, Moreing & Company of London. During the late war, Mr. Stuart was a member of the National Production Committee of the United States Fuel Administration and director of the national power conservation campaign.

HAROLD B. SMITH, president of the American Institute of Electrical Engineers, recently had two honorary degrees of Doctor of Engineering conferred upon him by Purdue University and Worcester Polytechnic Institute.

LESTER R. SELLERS, who for nearly three years has been in the employ of the station engineering department of the Philadelphia Electric Company is now with the Western Electric Company in the plant engineering department of its Hawthorne station.

THORNTON LEWIS, president of the American Society of Heating & Ventilating Engineers, was honored on July 18 by British members of the society with a testimonial dinner, which was also attended by officers of the British Institution of Heating & Ventilating Engineers.

W. R. PENDER, engaged in power plant betterment work, has recently been assigned to Tampico, Mexico, by the New York office of the Electric Bond & Share Company.

JOHN WALKER, formerly with the Dorr Company of New York City, has taken a position with the Schofield Burkett Construction Company of Macon, Ga.

FRANK J. MILLER, appointed by Governor Patterson as a member of the Oregon Public Service Commission to fill the vacancy caused by the death of Louis E. Bean, has been elected chairman of the commission, the post occupied by Mr. Bean at the time of his death. Mr. Miller was the first secretary of the original Oregon Railroad Commission, serving from 1891 to 1893.

DARIUS E. PECK, asistant manager of the law department of the General Electric Company since 1920, has been elected vice-president and general counsel of the company to succeed Allen H. Jackson, who retired on Aug. 1. Mr. Peck has had much experience in the public utility power field. He was formerly secretary of the Mohawk Hudson Power Corporation and is at present a director of the New York Power & Light Corporation.

BUSINESS NOTES

WAGNER ELECTRIC COMPANY announces the addition of W. H. Kretz to its transformer sales division. Mr. Kretz will cover territory in the Southwest.

FOGLE-HELSBY COMPANY, with offices in the Railway Exchange Building, Seattle, Wash., has been formed by William I. Fogle and George E. Helsby. The new concern will deal in fabricated structural steel, forgings, tanks, pipe, steel plate work, hammer-head cranes, lumber stackers and grapples. It will be the Northwest representative of the Northern Engineering Works, of Detroit; the Ames Iron Works, of Oswego, N. Y., and the Schwartz Engineering Company, of Denver, Colo.

UNITED LEAD COMPANY, Keokuk, Iowa, announces that its Keokuk plant will hereafter be known as the Midwest Carbide Corporation. This change will not affect the personnel of the original company.

LEEDS & NORTHRUP COMPANY announces the appointment of two new sales representatives. R. L. Sittinger will have an exclusive agency for its metered combustion control apparatus in New England. He will be located at 80 Federal St., Boston, Mass. Irvin C. DeHaven Engineering Company will represent it in most of Indiana, western Ohio and Kentucky, with offices in the State Life Building, Indianapolis, Ind.

AMERICAN HOIST & DERRICK COMPANY, of St. Paul, Minn., announces the removal of its office from 139 Townsend St., San Francisco, to 5515 Doyle Ave., Emeryville, Oakland, Calif. Boyd Nixon, who was in charge of the San Francisco office, will continue in charge.

TRADE CATALOGS

CIRCUIT BREAKERS—In bulletin 1145 the Allis-Chalmers Manufacturing Company describes its "Armorclad" oil-circuit-breaker equipment for power stations, sub-stations and general industrial purposes. Illustrations and wiring diagrams of this switchgear, in which all conductors are inclosed in a grounded metal casing, are a feature of the publication.

ELECTRICAL DEVICES—Among the bulletins recently issued by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., are the following: Magnetic Resistance Type Motor Starter, No. 20,406; Magnetic Motor Starters, No. 1661-D; Engine-Driven D.C. Generator, No. 20,414; Multiple Operator Arc Welding Equipment, No. 20,421; Nofuz Panelboard, No. D.M.F. 5,150; Engine-Driven Arc-Welding Set, No. 20,418; D.C. Drum Controller, No. 20,416; Network Protectors, No. 1,837. Leaflet 20,287-A, describing the Sharples process for reclaiming circuit breaker oils, has also been released.

VALVES—Catalog No. 35, recently issued by the Homestead Valve Manufacturing Company, Coraopolis, Pa., is an illustrated 52-page booklet giving constructional details, special features and prices of valves manufactured by this company. Illustrations of several valves built to meet special requirements are of considerable engineering interest.

CENTRAL STATIONS—The fifth section of a series of reprints known as "Modern Central Stations" has been released by the Ingersoll-Rand Company and A. S. Cameron Steam Pump Works, 11 Broadway, New York City. These reprints, from several technical magazines, include the following subjects: Progress in Steam Research; A Revised Mollier Chart for Steam; A General Steam Equation?; The Specific Heat of Superheated Steam From 30 to 120 Atmospheres and From Saturation Temperature to 450 Deg. C.; The Holland Station of the Pennsylvania-New Jersey Power System; 1,200 lb. Pressure, a Dollar Saver; Edison Adds 237,000 Hp. in 1928; And Now Steam Power Comes Into the Forefront; 100,000-kva. Edison Steam Unit; Gas Makes Ideal Fuel at Lake Pauline; Chesapeake Bay District Served by Vienna Station; Broad River Power Station Proves a Good Citizen; Features of 110,000-kw. Station at Hudson Avenue; Recent Developments at the Charles R. Huntley Station; Cahokia Station; and Deepwater, a Double-purpose Station.

STEAM TURBINES AND GENERATORS—About 50 photographs of various types and sizes of turbines, generators and accessories manufactured by Siemens Schuckert Turbine Works at Mulhein Ruhr, Germany, are contained in Bulletin No. 3179-1.

Coming Conventions

American Institute of Electrical Engineers. Pacific Coast Regional Meeting, Santa Monica, Calif. Sept. 3-6. F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Welding Society. Fall meeting at Cleveland, Ohio, Sept. 9-13. Secretary, M. M. Kelly, 33 West 39th St., New York City.

National Association of Power Engineers, 47th annual convention, Chattanooga, Tenn., Sept. 9-13. Fred Raven, secretary, 417 South Dearborn St., Chicago, Ill.

National Association of Practical Refrigerating Engineers. Twentieth annual convention at the William Penn Hotel, Pittsburgh, Pa., Nov. 4-7. Secretary, E. H. Fox, 5707 W. Lake St., Chicago, Ill.

National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York City, Dec. 2-7. Charles F. Roth, manager, Grand Central Palace, New York City.

America Society of Heating & Ventilation Engineers. Annual meeting in Philadelphia, Pa., Jan. 27-30, 1930, at the Benjamin Franklin Hotel. Secretary, A. V. Hutchinson, 33 W. 39th St., New York City.

World Engineering Conference, Tokyo, Japan, October, 1929. All correspondence should be addressed to the Secretary, World Engineering Conference, Nikon, Kogyo Club, Morunouchi, Tokyo.

FUEL PRICES

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.00 @ $2.35
Kanawha	Columbus	1.25 @ 1.50
Smokeless	Cincinnati	1.75 @ 2.00
Smokeless	Chicago	1.75 @ 2.25
S. E. Kentucky	Chicago	1.35 @ 1.60
Steam	Pittsburgh	1.55 @ 1.65
Gas Slack	Pittsburgh	1.00 @ 1.10
Big Seam	Birmingham	1.50 @ 1.75
Anthracite (Gross Tons)		
Buckwheat	New York	$2.50@$2.75
Barley	New York	1.50

FUEL OIL

New York—Aug. 8, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75c. per gal.; 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—July 24, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.3959 per bbl. or 42 gal.; 26@28 deg., $1.4409 per bbl.; 28@30 deg., $1.4959 per bbl.; 30@32 deg., $1.5409 per bbl.; 32@36 deg., gas oil, 4.276c. per gal.; 38@40 deg., distillate, 5.248c.

Pittsburgh — Aug. 6, f.o.b. local refinery, 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., 5.5c. per gal.

Philadelphia — Aug. 6, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 22 deg. plus, $1.575@$1.625 per bbl.; 23@27 deg., $2.10@$2.15 per bbl.

Cincinnati — Aug. 6, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5.25c. per gal.; 30@32 deg., 5.5c. per gal.

Chicago—July 23, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 65c. per bbl.; 26@30 deg., 85c. per bbl.; 30@32 deg., $1.00 per bbl.

Boston—Aug. 5, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.3c. per gal. 28@32 deg., 5.4c. per gal.

Dallas—Aug. 3, f.o.b. local refinery, 26@30 deg., $1.30 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Conn., Stamford—Stamford Hall Sanitarium, 70 Summer St., awarded contract 1 story, power house, Bedford St., to Hewlett Co., 886 Main St., Bridgeport. Estimated cost $50,000. Noted July 9.

Conn., Middletown—Connecticut Power Co., 335 Main St., will receive bids until August 13, service and office building, Columbia Ave. Estimated cost $100,000. Davis & Waldroff, 17 Whitney Ave., New Haven, are architects.

Conn., Waterbury—M. J. Daly & Sons, Inc., 543-555 Bank St., awarded contract 1 tory, boiler shop addition, Bank St., to T. G. Smith Co., 18 Orange St. Estimated cost $60,000.

Ill., Centralia—City takes bids about October 1, sewage treatment plant, including 2 centrifugal pumps, pumping station, plunge type sludge pump; 80 gpm. water supply pump, etc. Estimated cost $164,600. Pearse, Greeley & Hansen, 6 North Michigan Ave., are engineers.

Ill., Chicago—Howard Avenue Trust & Savings Bank, Howard and Ashland Aves., will receive bids about August 15, 4 story, office, bank and store building, including 2 elevators, mechanical ventilating system, at Howard and Malvern Aves. Estimated cost $500,000. J. J. Jenson, 1105 Lawrence Ave., is architect.

Ind., Monon—City plans improving light plant. Estimated cost $50,000. Municipal Engineering Co., 413½ Wabash Ave., Terre Haute, is engineer.

La., Alexandria—Board of State Engineers, New Court House, New Orleans, will receive bids August 26, pumping plant, 2 electrical driven pumps, and accessories, at mouth Bayou Rapides, Rapides Parish.

Massachusetts—Commonwealth of Massachusetts, Dpt. Mental Diseases, will receive bids August 16, group of hospital buildings, including heating, ventilating and electrical work, at Waltham, Lexington and Belmont. Estimated cost $1,200,000. G. Robb, 14 Beacon St., Boston, Mass., is architect. A. B. Franklin, Inc., 25 Haverhill St., Boston, is engineer.

Mass., Winchester—J. Downs, Arlington St., awarded contract for the construction of a boiler house and greenhouse to W. A. Wentworth Co., 107 Pacific St., Cambridge. Estimated cost $25,000.

Mich., Detroit—Packard Motor Co., East Grand Blvd., taking bids 3 story addition to power house, East Grand Blvd. Estimated cost $50,000. Private plans. Boiler plant equipment will be required.

Mich., Detroit—S. Plotkin, 604 Lafayette Bldg., will receive bids about August 15, 11 story apartment, including heating, ventilating, refrigeration, boiler, East Jefferson Ave. M. H. Finkel, 153 East Elizabeth St., is architect.

Mo., St. Louis—Syndicate forming c/o H. Newman, Inc., 4515 South Kingshighway Blvd., preliminary plans for the construction of apartment hotel, including steam heating, electric refrigerators, Skinker Blvd. Estimated cost $2,500,000.

N. J., Newark—Larkey Holding Co., c/o Fanning & Shaw, Archts., 49 Ward St., Paterson, takes bids on separate contracts about August 15, for the construction of 21 story office building, including steam heating, ventilating, boilers, etc., Market and Halsey Sts. Estimated cost $1,000,000.

N. Y., New York—Knickerbocker Ice Co., 41 East 42nd St., will receive bids in September on general contract for the construction of ice manufacturing plant, 409 East 60th St. Estimated cost $40,000.

N. Y., New York—G. T. Kirby, 57 East 56th St., having plans prepared altering boiler room, 30 East 57th St. Estimated cost $40,000. S. L. Strauss, 41 Union Square, is architect.

N. Y., New York—U. S. Veterans' Bureau, Arlington Bldg., Washington, D. C., takes bids until August 27, for the construction of an addition and refrigeration alterations, at Building 1, U. S. Veterans' Hospital.

N. Y., Yorkshire—Niagara Lockport & Ontario Power Co., Marine Trust Bldg., plans electric plant.

N. D., Grafton—City plans election August 22, to vote $80,000 bonds for the construction of municipal electric power and light plant. Druar & Milinowski, 500 Globe Bldg., St. Paul, Minn., are engineers.

Pa., Pittsburgh—C. F. Haudenshield, 21 Diamond St., plans the construction of 3 story, warehouse, including refrigeration plant, Pennsylvania and 22nd Aves. Estimated cost $150,000. R. Marlier, Empire Bldg., is architect.

Tenn., Jackson—City voted August 1, $750,000 bonds for the construction of a municipal electric light plant.

Tex., Elsa—Central Power & Light Co., c/o F. C. Ludden, District Manager, San Benito, taking bids for the construction 1 story, 25 ton capacity ice plant. Estimated cost $35,000. J. Marriott, Frost Bldg., San Antonio, is engineer.

Texas—Central Power & Light Co., c/o Frost Bldg., San Antonio, plans the construction substation at Larado; also 85 mi. 66,000 v. power transmission line, from Asherton to Larado. Estimated cost $100,000.

Tex., La Porte—City is having surveys made for the construction of a waterworks and distribution systems including pumping equipment, etc. F. Reynolds, mayor.

Utah, Mount Pleasant—City defeated $40,000 bonds for the construction of hydro-electric plant.

Va., Langley Field (br. Hampton)—Constructing Quartermaster, will soon award contract for the construction of a boiler house, etc., here.

W. Va., Hinton—Chesapeake & Ohio Railway Co., C. W. John, ch. engr., Richmond, Va., awarded contract for the construction of roundhouse and concrete coaling station, to John W. Cowper Co., Richmond, Va. Modern loading and conveying equipment will be required.

Ont., Belleville—City plans the construction of water purification system, including centrifugal pumps, electric motors, etc. Estimated cost $200,000. Gore, Nasmith & Storrie, Confederation Life Bldg., Toronto, are engineers.

Ont., Grimsby—Town plans constructing sewerage system, including clarifier motors, air compressors, etc. Estimated cost $100,000. F. A. Dallyn is city engineer.

Ont., Sudbury—Town, plans the construction of a pumping station in connection with sewage treatment work. Estimated cost $140,000. S. A. Purvis, Sudbury, is engineer.

Ont., Guelph—B. Marshall, Archt., 612 Sheridan Rd., Chicago, Ill., soon takes bids electrically operated pumping station, etc. for A. Cutten.

Ont., Toronto—Eighty Richmond St. W. Ltd, 80 Richmond St. W., awarded contract for a 25 story office building to Simcoe Construction Co. Ltd, Concourse Bldg. Estimated cost $1,000,000. Steam heating system, elevators, etc. will be installed.

Ont., Windsor—Auto Specialties, Ltd., Tecumseh Rd., awarded contract for the construction of fuel house and heating plant to Holbeck Engineering Co., Ponton Bldg., Cleveland, O. Estimated cost $78,000.

Ont., Windsor—Canadian National Railways, St. James St., Montreal, Que., plans railway station, including steam heating, near Windsor-Detroit Vehicular Tunnel. Estimated cost $1,000,000. J. Schofield, St. James St., Montreal, Que., is architect.

Mexico, Agua Caliente—Agua Caliente Co., c/o W. D. McAllister, Archt., 527 Commonwealth Bldg., San Diego, Calif., awarded contract for the construction of swimming pool, including power plant with 1,200 hp. capacity boilers, to American Bldg. & Investment Co., 2672 5th Ave., San Diego, Calif. Estimated cost $250,000.

Equipment Wanted

PUMP—Alturas, Calif.—E. E. Ellicott, city clerk, will receive bids until August 16, 1 deep well turbine pump, 1,000 gal. per min. capacity, with built in electric motor head, 220 to 440 v., 60 cycles, 3-phase type; capable of delivering through 3,000 ft. 8 in. pipe to tank, whose base is 92 ft. above ground, at pump whose height when full to be 42 ft. water surface 10 ft. below ground at pump, drawing down 70 ft.; also automatic electric control switches and panel board for pump motor.

AIR COMPRESSORS—Washington, D. C.—A. L. Flint, General Purchasing Agent, Panama Canal, will receive bids until August 19, air compressors, etc.

ENGINE GENERATOR—Hollis, Okla.—City plans installing 120 hp. Diesel engine generator set in Water Plant. Estimated cost $7,000. W. E. Green, city engr.

PUMPS—Oklahoma City, Okla.—Plans addition 8 new centrifugal pump units and four 8,000 steel storage tanks, at Oklahoma-City-Cimanon Pump Station. Estimated cost $130,000. Private plans.

TURBINE GENERATOR—Victoria, B. C.—British Columbia Electric Railway Co., will receive bids until August 31, for 15,500 hp. turbine generator and 2 mi. steel pipe for Jordon River Hydro-Electric Power Station. Estimated cost $1,500,000. G. M. Tripp, 1684 Yates St., is engineer.

Industrial Projects

Calif., Monrovia—FACTORY—Day & Night Water Heater Co., awarded contract for the construction of factory, to Hamm, Grant & Bruner, Inc., Ferguson Bldg., Los Angeles. Estimated cost $40,000.

Conn., East Hartford—AIRPLANE FACTORY—A. Kahn, Archt., Marquette Bldg., Detroit, Mich., will receive bids until August 15, for the constructing 2 story airplane factory, for Pratt Whitney Aircraft Co., 450 Capitol Ave., Hartford. Noted July 23.

Ill., Chicago—BRASS and COPPER PLANT—Dallas Brass & Copper Co., 820 Orleans St., awarded contract for the construction of 3 buildings, for sheet brass and copper plant, 6607 West Grand Ave., to Dahl-Stedman Co., 11 South LaSalle St. Estimated cost $500,000.

Md., Towson—GRINDER FACTORY—Black & Decker Mfg. Co., awarded contract for the construction manufacturing plant to W. H. Sands, East Pennsylvania Ave. Estimated cost $200,000.

Mass., Holyoke—PAPER MANUFACTURING PLANT—Chemical Paper Co., R. Bosworth, awarded contract for the construction of 2 story, paper manufacturing plant, to Casper Ranger Co., 20 Bond St. Estimated cost $175,000.

Mass., Springfield — Strathmore Paper Co., L. R. Howes in charge, will revise plans for the construction hydro-electric plant, Mittineague Sect. Former bids rejected. Estimated cost $40,000. Private plans.

Mich., Berrien Springs — TRANSMISSION FACTORY — Clark Equipment Co., Berrien Springs, awarded contract for the construction 1 story transmission factory to F. L. Shoemaker Constr. Co., East Congress St., Sturgis. Estimated cost $75,000.

Mich., Detroit—BODY FACTORY—Murray Body Corp., Clay Ave., awarded contract for the construction of 5 story body factory to H. G. Christman-Burke Co., Fisher Bldg. Electric motors are required.

Mich., Flint—FOUNDRY—Flint Foundry Co., 702 West Kearsley St., plans the construction 1 story foundry and office building, West Kearsley St. Estimated cost $100,000. Wright & Nice, 22 Dort Bldg., Detroit, are architects. Electric motors will be required.

N. J., Edgewater—ASSEMBLY PLANT—A. Kahn, archt., Marquette Bldg., Detroit, Mich., takes bids about August 15 for the construction of assembly plant, incl. oil house, water storage, for Ford Motor Co., Dearborn, Mich. Electric motor equipment for detached power plant supply.

N. J., Newark—ELECTRICAL EQUIPMENT FACTORY—Westinghouse Electric & Mfg. Co., 150 Bway., New York, plans the construction manufacturing and distributing plant, here. Estimated cost $8,000,000.

N. J., Plainfield—PRINTING MACHINERY PLANT — Wood Newspaper Machinery Corp., 688 South 2nd St., plans the construction 1 story printing machinery plant, Grand Ave. Estimated cost $45,000.

O., Canton—DROP FORGING FACTORY—Canton Drop Forging & Mfg. Co., 300 Odd Rown Pl., plans the construction of 1 story factory, Willett Ave. E. Estimated cost $100,000. Private plans.

O., Dayton—BAKERY—Green & Green Co., Cincinnati, plans the construction 4 and 6 story baking plant addition, Cincinnati St. Estimated cost $500,000. Engineer and architect not selected.

Okla., Tulsa—CEMENT PLANT—Tulsa Cement Co., c/o C. B. Douglas, Mayor Bldg., plans cement plant, near here. Estimated cost $1,800,000.

Pa., Belle Vernon—BYPRODUCTS PLANT—Pittsburgh Steel Co., Union Trust Bldg., plans by products plant, Gibsonton. Estimated cost $3,000,000. Private plans.

Pa., Easton—DRINKING CUP PLANT—Ballinger Co., archt., 12th and Chestnut Sts., Phila., will receive bids until August 15, 3 story, drinking cup manufacturing plant, for Industrial Drinking Cup Co. Estimated cost $100,000.

Tex., Midland—OIL REFINERY—Humble Oil & Refining Co., Humble Bldg., Houston, will build gasoline refining plant, here. $1,000,000.

Tex., San Antonio—AIRCRAFT FACTORY—Alamo Aircraft Corp., c/o B. Hammond, taking bids aircraft manufacturing plant. Estimated cost $200,000.